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2012 Chart Book

University of Massachusetts Amherst Cranberry Station

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CRANBERRY 2012 CHART BOOK

MANAGEMENT GUIDE FOR MASSACHUSETTS

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Carolyn DeMoranville, Director
UMass Extension Mailing Signoff

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NOTICE: The Cranberry Station and its staff do not assume any responsibility for personal injury or property damage. All pesticides mentioned in this publication are registered and cleared for the suggested uses according to general registrations and state laws in effect on the date of this publication. The label is the law. Pesticides other than those listed have been registered for use on cranberry but are, for one reason or another, not currently recommended. When trade names are used for identification, no product endorsement is implied, nor is discrimination intended against similar materials.

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i Cautions

CAUTIONS

Fungicides

<u>Product</u>	<u>Maximum allowable formulation</u>	<u>Pre-harvest interval (PHI) (days)</u>	<u>Restricted entry interval</u>	<u>Maximum number of applications</u>
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CHLOROTHALONILS (*Restricted Use)

Bravo Ultrex	18 lb	50 days	12 hrs	3
Bravo Weather Stik	19.5 pt	50 days	12 hrs	3
Chloronil 720	19.5 pt	50 days	12 hrs	3
Chlorothalonil 720 SC	19.5 pt	50 days	12 hrs	3
Echo 90DF	17.25 lb	50 days	12 hrs	3
Echo 720	21 pt	50 days	12 hrs	3
Equus DF	18 lb	50 days	12 hrs	3
Equus 500 ZN	27.75 pt	50 days	12 hrs	3
Equus 720 SST	19.5 pt	50 days	12 hrs	3

COPPERS (copper hydroxide)

Champ DP Dry Prill	28 lb	No PHI	24 hrs	5
Champ Formula 2 Flowable	26.6 pt	No PHI	24 hrs	5
Champ WG	40 lb	No PHI	24 hrs	5
Copper-Count-N	24 qt	No PHI	12 hrs	3
Cuprofix MZ Disperss	42 lb	30 days	24 hrs	3
Cuprofix Ultra 40 Disperss	15 lb	No PHI	48 hrs	3
Kocide DF	24 lb	No PHI	24 hrs	3
Kocide 2000	18 lb	No PHI	48 hrs	3
Kocide 3000	10.5 lb	No PHI	48 hrs	3
Nordox	24 lb	No PHI	24 hrs	3
Nu-Cop HB	12 lb	No PHI	24 hrs	3
Nu-Cop 3L	32 pt	No PHI	24 hrs	3
Nu-Cop 50 DF	24 lb	No PHI	24 hrs	3
Top Cop with Sulfur	2 qt	No PHI	24 hrs	3
3 lb Copper Flowable	32 pt	No PHI	24 hrs	3

MANCOZEBS (EBDC'S)

Dithane DF RainShield	18 lb	30 days	24 hrs	3
Dithane F-45 Rainshield	14.4 qt	30 days	24 hrs	3
Dithane M-45	18 lb	30 days	24 hrs	3
ManKocide	96 lb	30 days	24 hrs	3
Manzate Flowable	14.4 qt	30 days	24 hrs	3
Manzate Pro-Stick	18 lb	30 days	24 hrs	3
Penncozeb 4 FL	14.4 qt	30 days	24 hrs	3
Penncozeb 75DF or 80WP	18 lb	30 days	24 hrs	3

MANEBS (EBDC'S)

Maneb 75 DF, Maneb 80 DF	18 lb	30 days	24 hrs	3
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Other Products

Abound (azoxystrobin)	93 oz	3 days	4 hrs	6
Aliette WDG (fosetyl-al)	20 lb	3 days	12 hrs	4
Ferbam Granuflo (ferbam)	30 lb	50 days	24 hrs	5
Indar 2F (fenbuconazole)	48 oz	30 days	12 hrs	4
Indar 75 WSP (fenbuconazole)	16 oz	30 days	12 hrs	4
Legion 80WDG (aluminum-tris)	20 lb	3 days	12 hrs	4
Phostrol (phosphites)	24 pt	3 days	4 hrs	4
ProPhyt (phosphites)	12 pt	No PHI	4 hrs	3
Ridomil Gold GR (mefenoxam)	105 lb	45 days	48 hrs	3
Ridomil Gold SL (mefenoxam)	5.25 pt	45 days	48 hrs	3

CAUTIONS

<u>Insecticides</u>	Maximum actual toxicant/A	Pre-harvest interval (PHI)	Restricted entry interval (REI)	Maximum number of applications
Product				
Actara (thiamethoxam)**	0.188 lbs	30 days	12 hrs	(12 oz/A)***
Admire (imidacloprid)	0.5 lbs	30 days	12 hrs	(0.5 lb ai/A)***
Altacor (chlorantraniliprole)	0.2 lbs	1 day	4 hrs	3 (9 oz/A)
Assail (acetamiprid)	0.26 lbs	1 day	12 hrs	2
Avaunt (indoxacarb)	0.44 lbs	30 days	12 hrs	(24 oz/A)***
Belay (clothianidin)	0.2 lbs	21 days	12 hrs	(12 fl oz/A)***
<i>B.t.</i> based products	NA	No PHI	4 hrs	-
Confirm (tebufenozide)	1 lb	30 days	4 hrs	4
Delegate (spinetoram)	0.305 lbs	21 days	4 hrs	6
Diazinon*	12 lb	7 days	5 days	3
Imidan (phosmet)	15.6 lbs	14 days	24 hrs/3 days	(15.6 lb/A)***
Intrepid (methoxyfenozide)**	1 lb	14 days	4 hrs	(64 fl oz/A)***
Lorsban (chlorpyrifos)*	1.5 lbs	60 days	24 hrs	2
Nematodes	-	No PHI	0 hrs	-
Nexter (pyridaben)	1 lb	21 days	12 hrs	2
Oberon (spiromefesin)	0.75 lb	3 days	12 hrs	3
Orthene (acephate)	1 lb	90/75 days	24 hrs	1
Pyrenone or Pyronyl	60% PBO + 6% Pyrethrins	No PHI	12 hrs	-
Sevin (carbaryl)	4 lb	7 days	12 hrs	5
SpinTor (spinosad)	0.45 lbs	3 days	4 hrs	6

* = restricted use pesticide, requires a pesticide license to buy and apply.

** = Zone II restricted and restricted use, requires a pesticide license to buy and apply.

*** = No specific application limitations except the total amount applied per acre.

<u>Herbicides</u>	Maximum allowable formulation	Pre-harvest interval (PHI) (days)	Restricted entry interval (REI)	Maximum number of applications
Product				
Callisto (mesotrione)	16 oz	45 days	12 hrs	2
Casoron (dichlobenil)	100 lb	N/A	12 hrs	N/A
Devrinol 50DF (napropamide)	18 lb	N/A	24 hrs	3
Evital (norflurazon)	160 lb	N/A	12 hrs	1
Fusilade (fluazifop)	N/A	1 year	12 hrs	N/A
Poast (sethoxydim)	5 pt	60 days	12 hrs	N/A
Reglone (diquat dibromide)	N/A	1 year	when dry	N/A
Roundup, Rodeo (glyphosate)	N/A	30 days	12 hrs	N/A
Roundup Weather Max (glyphosate)	N/A	30 days	4 hrs	N/A
Select Max (clethodim)	64 oz	30 days	24 hrs	N/A
Stinger (clopyralid)	16 oz	50 days	12 hrs	2
Weedar 64*	N/A	30 days	48 hrs	1
2,4-D granular*	N/A	N/A	12 hrs	N/A

Recommended water-holding times: (Check the label on the product you are using to verify information.)

At least 1 day: Avaunt

At least 3 days: Chlorothalonil products (e.g., Bravo), Nexter, and Diazinon.

At least 5 days: Chlorpyrifos (e.g., Lorsban) products and Actara.

At least 14 days: Abound fungicide.

Time Needed for Certain Pesticides to be Rainfast

Roundup	6 hr	Callisto	4 hr	Poast	1 hr
Confirm, Intrepid	6 hr	Roundup WeatherMax	1-2 hr	Select Max	1 hr
SpinTor	5 hr				

iii Resistance Management

Resistance Management

Prepared by Martha M. Sylvia

In an effort to manage resistance with our pesticides, many labels now come with a “group” number assigned to them. The group ID is specific among insecticides, herbicides and fungicides. Most of our cranberry pesticides are in their own group with the exception of organophosphates and neonicotinoids. The following 3 pages show the groupings for our cranberry pesticides. The goal in resistance management is for growers to not repeatedly use compounds that fall within the same group. Resistance management may include alternating products with different modes of action or limiting the total number of applications per season.

Fungicide Resistance Action Committee (FRAC) <http://www.frac.info/frac/index.htm>

The group for fungicide resistance is the Fungicide Resistance Action Committee (FRAC). Their goal is to prolong the effectiveness of fungicides that are likely to encounter resistance problems and to limit crop losses should resistance appear. For cranberry, Ridomil and Abound (and potentially Indar) are fungicides that are at high risk for resistance development. They should not be used repeatedly and should be carefully alternated with other fungicides from other groupings. See grouping of cranberry fungicides on page vi. Only a few of our cranberry fungicides are labeled for resistance, but for those that are, a box like this would appear on the front of the label:

GROUP **11** FUNGICIDES

Herbicide Resistance Action Committee (HRAC)

<http://www.hracglobal.com/Home/tabid/121/Default.aspx>

The Herbicide Resistance Action Committee developed a classification of herbicides according to their mode of action. A similar system to FRAC has been developed by the Weed Science Society of America (WSSA) using numbers instead of letters to designate the categories. This classification is found on a few herbicide labels, for example Callisto labels have this marking:

GROUP **27** HERBICIDE

Herbicide resistance is a world-wide phenomenon with 218 documented cases. Selection of herbicide-resistant weed populations is often the result of the continuous use of the same herbicide or herbicides with the same mode of action. A key step in resistance management is to minimize the continuous use of herbicides with the same mode of action through rotations and combinations of products. One of the purposes of these classification systems is to make it easier for farmers and farm advisors to understand which herbicides share the same site of action without having to actually know the biochemical basis.

In cranberry, our biggest concern is our new reliance on Callisto. Be sure to rotate other compounds into your herbicide schedule. Do not treat the same bog with Callisto year after year. See table of cranberry herbicides by grouping on page v.

Insecticide Resistance Action Committee (IRAC) <http://www.irac-online.org/>

An Insecticide Resistance Action Committee (IRAC) has been formed to assemble the information for insecticides. Their goal is to manage resistance to keep agriculture sustainable. For cranberry, organophosphates and neonicotinoids are our biggest concern. We are reliant on several compounds in these groupings. As long as growers remember to alternate between groupings and not repeat same mode-of-action compounds over and over, we should be able to keep newer compounds viable for decades. See Cranberry Insecticides by grouping on next page. Insecticides are grouped clearly by chemical makeup and most insecticide labels now included markings such as this:

Group 5 INSECTICIDE

INSECTICIDE RESISTANCE ACTION COMMITTEE (IRAC) GROUPING
FOR CRANBERRY INSECTICIDES

GROUP 1	ORGANOPHOSPHATES AND CARBAMATES Acetylcholine esterase inhibitor	Diazinon Imidan Lorsban Orthene Sevin	diazinon phosmet chlorpyrifos acephate carbaryl
GROUP 3	PYRETHRINS Sodium channel modulators	Pyreth-It Pyganic	pyrethrin pyrethrin
GROUP 4	4A NEONICOTINOIDS Nicotinic Acetylcholine receptor agonists	Actara Admire Assail Belay	thiamethoxam imidacloprid acetamiprid clothianidin
GROUP 5	SPINOSYNS Nicotinic Acetylcholine receptor allosteric activators	Delegate SpinTor	spinetoram spinosad
GROUP 11	Microbial disruptors of insect midgut membranes	Dipel, Xentari Biobit	<i>Bacillus</i> <i>thuringiensis</i>
GROUP 12	Inhibitors of mitochondrial ATP synthase	Nexter	propargite
GROUP 18	Ecdysone agonists / molting disruptors	Confirm Intrepid	tebufenozide methoxyfenozide
GROUP 22	Voltage-dependent sodium channel blockers	Avaunt	indoxacarb
GROUP 23	Inhibitors of acetyl CoA carboxylase	Oberon	spiromesifen
GROUP 28	DIAMIDES Ryanodine receptor modulators	Altacor	chlorantraniliprole

HERBICIDE RESISTANCE ACTION COMMITTEE (HRAC) GROUPING FOR CRANBERRY HERBICIDES					
Group numbering at right from Weed Science Society of America (WSSA) as on pesticide labels					
HRAC GROUP	SITE OF ACTION	CHEMICAL FAMILY	ACTIVE INGREDIENT	BRAND NAME	WSSA GROUP
A	Inhibition of acetyl	Aryloxyphenoxy-propionate	fluazifop-P-butyl	Fusilade	1
	CoA carboxylase	‘FOPs’			
	(ACCase)	Cyclohexanedione ‘DIMs’	clethodim sethoxydim	Prism, Select, Poast	1
C1	Inhibition of photosynthesis at photosystem II	Triazine	simazine	Princep	5
F1	Bleaching: Inhibition of carotenoid biosynthesis at the phytoene desaturase step (PDS)	Pyridazinone	norflurazon	Evital	12
F2	Bleaching: Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	Triketone	mesotrione	Callisto	27
G	Inhibition of EPSP synthase	Glysine	glyphosate	Roundup	9
K3	Inhibition of VLCFAs (Inhibition of cell division)	Acetamide	napropramide	Devrinol	15
L	Inhibition of cell wall (cellulose) synthesis	Nitrile	dichlobenil	Casoron	20
		Quinoline carboxylic acid	quinclorac	Quinstar	26
O	Action like indole acetic acid (synthetic auxins)	Quinoline carboxylic acid	quinclorac	Quinstar	4
		Phenoxy-carboxylic-acid	2,4-D	Weedar 64	4
		Pyridine carboxylic acid	clopyralid	Stinger	4

FUNGICIDE RESISTANCE ACTION COMMITTEE (FRAC) GROUPING FOR CRANBERRY FUNGICIDES							
Mode of Action	TARGET SITE	GROUP NAME	CHEMICAL GROUP	COMMON NAME	TRADE NAME	FRAC CODE	comments
A	A1:	PA - fungicides	acylalanines	metalaxyl	Ridomil	4	High Risk
	RNA polymerase I	PhenylAmides					
C	C3:	Qol-fungicides	methoxy-acrylates	azoxystrobin	Abound	11	High Risk
	cytochrome bc1 at Qo site	Quinone outside inhibitors					
G	G1:	DMI-fungicides	triazoles	fenbuconazole	Indar	3	Medium Risk
	c14-demethylase in sterol biosynthesis	DeMethylation Inhibitors					
Unk	Unknown	phosphonates	ethyl phosphonates	fosetyl-Al	Aliette	33	Low Risk
				aluminum-tris	Legion		
				phosphorous acids and salts	Phostrol ProPhyt	33	Low Risk
MS	Multi-site contact activity	inorganic	inorganic	copper (salts)	Champ	M1	Low Risk
MS	Multi-site contact activity	dithiocarbamates	dithiocarbamates	ferbam	Ferbam	M3	Low Risk
				mancozebs	Manzate Dithane Penncozeb		
				manebs	Maneb	M3	Low Risk
MS	Multi-site contact activity	chloronitriles	chloronitriles	chlorothalonil	Bravo Echo Equus	M5	Low Risk

vii Warnings

WARNING!!

PESTICIDES ARE POISONOUS. READ AND FOLLOW ALL DIRECTIONS AND SAFETY PRECAUTIONS ON LABELS. HANDLE CAREFULLY AND KEEP ORIGINAL LABELED CONTAINERS IN LOCKED STORAGE AREA. DO NOT CONTAMINATE FORAGE, STREAMS OR PONDS. DISPOSE OF EMPTY CONTAINERS IN A LEGAL MANNER.

REPEATED EXPOSURE TO ORGANOPHOSPHATE (SUCH AS DIAZINON, IMIDAN AND LORSBAN) INSECTICIDES MAY, WITHOUT SYMPTOMS, INCREASE SUSCEPTIBILITY TO PHOSPHATE POISONING. ALL PESTICIDE TREATED BOGS MUST NOT BE ENTERED UNTIL RESTRICTED ENTRY TIMES HAVE ELAPSED (SEE LABEL). WORKERS SHOULD BE NOTIFIED PRIOR TO TREATMENT. TELL FAMILY AND CO-WORKERS. MAKE CERTAIN YOUR DOCTOR UNDERSTANDS. AFTER AN ACCIDENT, THERE MAY NOT BE TIME.

IF SYMPTOMS OF ACUTE PESTICIDE POISONING OCCUR, IMMEDIATELY TAKE VICTIM AND THE APPROPRIATE PESTICIDE LABEL OR CONTAINER TO THE NEAREST HOSPITAL EMERGENCY ROOM. FOR INFORMATION AND ADVICE AT ANY TIME OF DAY OR NIGHT, CALL THE MASSACHUSETTS POISON CONTROL SYSTEM AT: **1-800-682-9211**

REMINDER FOR RESPONSIBLE APPLICATORS

RESTRICTED USE COMPOUNDS (DIAZINON, LORSBAN, ACTARA, BRAVO, INTREPID AND 2,4-D) REQUIRE A PRIVATE APPLICATOR CERTIFICATION TO BUY, HANDLE, AND APPLY. THIS CERTIFICATION IS AVAILABLE THROUGH THE MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES (MDAR): <http://www.mass.gov/agr/pesticides/licensing/index.htm>.

DIAZINON AND LORSBAN ARE FEDERALLY RESTRICTED. ACTARA, ALL CHLOROTHALONIL PRODUCTS (BRAVO, ETC.), AND INTREPID ARE STATE RESTRICTED DUE TO GROUNDWATER CONCERNS. 2,4-D IS STATE RESTRICTED DUE TO TOXICITY.

REMEMBER THAT ALL CHLOROTHALONIL PRODUCTS (BRAVO, ETC.), DIAZINON, IMIDAN, LORSBAN AND NEXTER ARE EXTREMELY TOXIC TO FISH AND CAN CAUSE FISH KILLS. ABOUND, AVAUNT, COPPER FUNGICIDES, INDAR, MANCOZEBS, AND SEVIN ARE ALSO TOXIC TO FISH.

TO AVOID CONTAMINATION, DO NOT CLEAN EQUIPMENT OR DISPOSE OF WASTES NEAR OPEN WATER. DRIFT OR RUNOFF OR RELEASE OF CONTAMINATED DITCH WATER FROM TREATED AREAS MAY BE HAZARDOUS TO FISH OR OTHER AQUATIC ORGANISMS IN ADJACENT AQUATIC SITES.

FOLLOWING ANY PESTICIDE APPLICATIONS, HOLD WATER AS LONG AS POSSIBLE.

CAUTIONS

1. Pesticide-treated bogs may need to be posted. Check labels. Workers and scouts should be notified prior to treatments, and informed about re-entry times. See CCCGA website for more info on sign posting:
<http://www.cranberries.org/growers/advisories.html>.
2. **READ AND FOLLOW LABEL INSTRUCTIONS.** The label is the law! Current labels and MSDS can be found on the CDMS website: <http://www.cdms.net/LabelsMsds/LMDefault.aspx>. Do not use a pesticide for control of a pest not on the label unless a specific recommendation is made by a person authorized to do so.
3. Make all pesticide applications in a manner to prevent contamination of streams, ponds, and public ways, and impound water as long as possible after applying.
4. Be aware of and adhere to guidelines regarding distances from site of chemical application to protected areas. Consider addition of drift retardants.
5. Many insecticides are highly toxic to bees. Check label and choose options that are non-toxic or that can be used safely.
6. Stored pesticides may deteriorate. Avoid freezing of liquid formulations. It is usually not advisable to use the holdover materials in opened containers. Follow regulations of the MDAR Pesticide Program when disposing of pesticides and their containers.
7. **CONCENTRATE SPRAYS** may injure new growth, bloom and small berries particularly in hot, humid weather or if the emulsifiable concentrate (EC) content nears 50% of mixture.

DISEASE MANAGEMENT 2012

Prepared by Frank L. Caruso

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
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UPRIGHT DIEBACK

This disease can be reduced if heat or drought stress is minimized or eliminated through the proper use of irrigation during July and August. Vines may be made more susceptible to the disease if they have been subjected to winter injury or oxygen deficiency.

APRIL 25	Champ DP Dry Prill	5.3 lb	Must be applied pre-bloom.
THROUGH	Champ Formula 2 Flowable	5.3 pt	24-hour restricted entry interval.
MAY 15	Champ WG	8 lb	

CHLOROTHALONIL FORMULATIONS

Bravo Ultrex	3.8 – 6 lb	12-hour restricted entry interval. One
Bravo Weather Stik	4 – 6.5 pt	pre-bloom application should be applied
Chlorothalonil 720 SC	4 – 6.5 pt	after the terminal bud has broken dormancy
Chloronil 720	4 – 6.5 pt	and begun to swell or has begun new growth.
Echo 720	4 - 7 pt	Exact timing will depend on whether
Echo 90DF	3.25 - 5.75 lb	the variety is early or late- season.
Equus DF	3.8 – 6 lb	
Equus 500 ZN	5.75 – 9.25 pt	
Equus 720 SST	4 – 6.5 pt	

For all above chlorothalonil formulations: Hold water for 3 days after application. When chlorothalonil formulations are to be used in a bed subject to Zone II regulations, growers must follow the required process to determine if these products may be used. See Zone II Section, page 64. The maximum allowable number of chlorothalonil applications is 3. If a chlorothalonil application is used for upright dieback control, only 2 fruit rot applications are allowed. Do not mix with B.t. based products (Dipel, etc.).

PHYTOPHTHORA ROOT ROT

This disease can be controlled with a combination of drainage improvements (digging new lateral ditches and maintaining existing ditches, installing drain tile, adding crushed stones, etc.), sanding the low areas, fertilizing plants peripheral to dead areas to stimulate root growth and/or using a soil fumigant to renovate particular sections. Spread of the pathogen can be prevented through the judicious use of water when flooding several individual beds for water harvesting, by cleaning and sterilizing equipment and footwear with 10% Clorox solution or steam before going from infested to non-infested beds, and by using cranberry vines free from the pathogen when replanting renovated sections or new beds.

Three fungicide applications per season are recommended for newly diagnosed instances. As areas of dieback recover, consult with the Extension Plant Pathologist regarding the fungicide schedule. The second application should occur 60-90 days after the first but 45 days before harvest (Aliette, Ridomil). The third application should be done after harvest, preferably prior to November 15. Ridomil must be watered in after application. Run the sprinklers for 3 hours after application to water the fungicide into the root zone. Too much water, however, may push the chemical past the root zone. Therefore, do not apply if more than 0.5 inch of rainfall is forecast or if the sprinklers will need to be run for more than 5 hours during the first few days after application. The drainage should be improved BEFORE applying any fungicide to the affected bed.

2 Diseases

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
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PHYTOPHTHORA ROOT ROT (CONT.)

APRIL 25 THROUGH MAY 15 (1 st application)	Aliette WDG	5 lb	Do not exceed 4 applications per year.
	Legion 80 WDG	5 lb	Do not tank mix with copper compounds, adjuvants, surfactants or foliar fertilizers, or phytotoxicity may occur. Foliar application.
	Phostrol	5-6 pt	30 day application interval, 3-day PHI, foliar application.
	ProPhyt	4 pt	No PHI, 3-week interval.
	Ridomil Gold SL	1-1.75 pt	Apply by ground or chemigation equipment. Do not apply SL by air. Use a minimum of 20 gallons water/A when applied by ground.
	Ridomil Gold GR	20-35 lb	Apply by ground or air. Any formulation can be used for spot treatment if the affected area(s) are small.

FRUIT ROT

This is the most prevalent disease problem that cranberry growers face from season to season. The degree of fruit rot that occurs in different beds during different growing seasons is dependent on many factors. Weather, density of vine growth, and drainage are among the most important factors. Fungicides are an important strategy for the control of fruit rot. Most berry infection occurs during the bloom period. Applications typically begin during early bloom (mid-June). Once the fruit has set and begun to increase in size (mid-late July), further fungicides are no longer necessary. The choice of fungicides, the rate of the fungicide, and the time interval between applications are dependent on the individual bed and its past incidence of fruit rot.

Fungicide decisions should be based on the Keeping Quality Forecast (KQF) found on the Station's website: <http://www.umass.edu/cranberry/cropinfo/keepqf.html>. If the forecast is good to excellent, consider fewer applications and/or lower rates of the fungicides. History of the cranberry bed is also important: if a bed is prone to fruit rot, one will need to be more conservative in the decision to reduce the total amount of active ingredient. Four fungicide applications are usually necessary for a bed prone to fruit rot. One or two fungicide applications may be adequate for a bed with very little fruit rot in previous growing seasons. Fungicide applications are more important when the berries will be harvested for fresh fruit, as this fruit will be held in storage for extended periods. Storage rot is not a concern for berries that are water harvested, as these berries will immediately be frozen in most cases. Normally, 3-5% fruit rot at delivery is considered acceptable. If in doubt, call the Extension Plant Pathologist.

EARLY BLOOM (10-20%), THEN AT 10-14 DAY INTERVALS	Bravo Ultrex	3.8-6.0 lb	<u>CHLOROTHALONIL FORMULATIONS</u> Use the maximum rate in beds with high rot incidence on a 10-day schedule. Zone II restricted, 3 applications/season 12 hr REI, hold water for 3 days.
	Bravo Weather Stik	4-6.5 pt	
	Chloronil 720	4-6.5 pt	
	Chlorothalonil 720 SC	4-6.5 pt	See chlorothalonil note at top of next page!!
	Echo 720	4-7 pt	
	Echo 90DF	3.25-5.75 lb	
	Equus DF	3.8-6.0 lb	
	Equus 500 ZN	5.75-9.25 pt	
	Equus 720 SST	4-6.5 pt	

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
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FRUIT ROT (CONT.)

For all chlorothalonil formulations: When chlorothalonil formulations are to be used in a bed subject to Zone II regulations, growers must follow the required process to determine if these products may be used. See Zone II Section, page 64. The maximum allowable number of chlorothalonil applications is 3. If 1 Bravo application was used for upright dieback control, only 2 fruit rot applications are allowed. Do not mix with Dipel. 12-hour restricted entry, note 6.5 day eye irritant! Do not release irrigation water for at least 3 days following application. Existing product may be used according to the label.

Abound	6.2-15.5 oz	Although 6 applications are allowed, no more than 2 applications should be used. See Resistance Management section page iii Use this fungicide for the earlier applications spaced 7-10 days. Hold water for 14 days.
Indar 75 WSP	4 oz	Do not use more than 2 apps. Do not use prior to bloom. 7-14 days between apps. 30 day PHI.
Indar 2F	6-12 oz	

For Abound and Indar: Resistance development to Abound and Indar by the fruit rot fungi is a very real and serious threat. Applications of the fungicide should be made pre-infection rather than post-infection to minimize resistance development. One application of each fungicide is recommended per growing season unless the Keeping Quality Forecast (KQF) predicts poor or worse keeping quality. Use Abound very carefully and avoid drift if the bed is next to a McIntosh apple orchard, as the fungicide is highly phytotoxic to this cultivar.

Ferbam Granuflo	6 lb	Do not apply more than 5 times. Apply at 14-day intervals. Using rates below recommended rate will be ineffective. 50-day PHI, 24-hr REI.
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EARLY BLOOM, THEN AT 7-10 DAY INTERVALS	Dithane DF Rainshield	3-6 lb	Addition of spray adjuvants will improve distribution and deposition for all of the maneb or mancozeb compounds.
	Dithane F-45 Rainshield	2.4-4.8 qt	
	Dithane M-45	3-6 lb	
	Penncozeb 4FL	2.4-4.8 qt	
	Penncozeb 75DF	3-6 lb	
	Penncozeb 80WP	3-6 lb	

MID-BLOOM, THEN AT 7-10 DAY INTERVALS	Cuprofix MZ Disperss	7.5-14 lb	Addition of spray adjuvants will improve distribution and deposition for all of the maneb or mancozeb compounds.
	Cuprofix Ultra 40 Disperss	5 lb	
	Maneb 75 DF	4.8-6.0 lb	
	ManKocide	10.5 lb	
	Maneb 80 WP	4.8-6.0 lb	
	Manzate Flowable	2.4-4.8 qt	
	Manzate Pro-Stick	3-6 lb	
	Top Cop with Sulfur	2 qt	

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DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
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FRUIT ROT (CONT.)

LATE BLOOM,	Champ Formula 2 flowable	5.33 pt
THEN ONE	Champ DP Dry Prill	5.6 lb
OR TWO	Champ WG	8 lb
APPLICATIONS	Copper-Count-N	8 qt
AT 10-14 DAY	Kocide DF	8 lb
INTERVALS	Kocide 2000	6 lb
	Kocide 3000	3.5 lb
	Nordox	8 lb
	Nu-Cop HB	4 lb
	Nu-Cop 3L	5.33-10.67 pt
	Nu-Cop 50 DF	8 lb
	3lb copper flowable	10.67 pt

FRUIT ROTS - CULTURAL CONSIDERATIONS

Late Water: Holding late water (flooding from mid-April to mid-May) will improve berry quality by disrupting the life cycles of rot-inducing fungi. In late water years, fungicide rates and/or the number of total applications can be reduced with no sacrifice in fruit quality. The fungicide program should not be eliminated completely or vine diseases may be a problem the following growing season. The number of fungicide applications can be reduced and the lowered rates can also be used during the first year after late water. Fungal inoculum will begin to build up during the second year after late water.

Lush Vines: Where fertilizer applications have been heavy, vines will tend to become very overgrown. This will lead to poor air circulation, retention of high humidity, and slow drying-out of heavy dew. These conditions encourage infection by the fungi that cause fruit rot and red leaf spot. When growth is excessive, pruning is recommended to promote air circulation in the vine canopy.

Trash Removal: Cranberry leaves, stems, and fruits left behind after harvest are colonized by several fungi that cause field and storage rot. This trash can serve as an inoculum source for fungal infections of the uprights, blossoms, or fruits in subsequent growing seasons. If the bed was dry-harvested, trash should be removed from the bed with a post-harvest flood in the fall or from the winter flood before it is withdrawn in February or March. Remove trash from water-harvested beds during harvest or as soon after as possible. Trash piles should not be left next to the bed. Trash should be deposited at least a quarter mile from the bed if possible. Self-pollinated seeds in berries left behind on the bog may germinate in the soil and possibly produce plants that are the typical "mongrels". These genotypes may produce much vegetation but few berries, and in worst case scenarios, may take over the productive vines in the bed.

Irrigation: When irrigation is necessary, sprinkler systems should be run for up to 4-5 hours in the early morning, and not in the early evening. Vines can get watered with minimal evaporation, and the surface of the vines can dry out in the sun's heat. When watering is done in the early evening, the vines are kept wet for an extended time period, thus creating favorable conditions for infection by the fruit rot fungi. On days with excessive temperatures (>100°F on the bed), particularly in newly planted or recently sanded beds, sprinklers should be run for 1-2 hours in the late morning or early afternoon to cool the vines and berries and to prevent injury. Sprinklers should be run to prevent scalding of the fruit when all of the following conditions persist: (1) dewpoints of 55°F or less during midday and afternoon hours, (2) high temperatures of 80°F or more, (3) clear or scattered sky conditions during the day, (4) bed soil moisture is low, (5) wind speeds average greater than 11 mph, and (6) no rainfall has occurred during the last 48 hours. This

Diseases 5

"forecast" is based on research performed in New Jersey. Scalded berries are typically browned on one side, with a clear demarcation between the brown area and the green (usually) area of the fruit. The rotted area in a berry affected with fruit rot typically has an area of anthocyanin production (reddish border) adjacent to the affected area. After seven days, a scalded berry will be hard to discern from a totally rotted berry, particularly since fungi will colonize the stressed scalded berry.

Resistant Varieties: When replanting bogs or planting new bogs, certain varieties with proven field rot resistance should be considered: Black Veil, Foxboro Howes, Matthews, Shaw's Success, and Wilcox. We are waiting to see how Crimson Queen, Demoranville, Grygleski and Mullica Queen rate as far as fruit rot susceptibility goes.

Research is still needed on the consistency of these cultivars to produce good crops. Small plantings are encouraged initially. Howes and Stevens also have good fruit rot resistance. Varieties can be identified at the Cranberry Station by bringing in uprights with attached full-size fruit.

One or two fungicide applications during the first two years after planting will help reduce fungal inoculum and may reduce fruit rot in subsequent years.

DISEASE/ TIMING	PESTICIDE/ FORMULATION	RATE (amt/A)	COMMENTS/RESTRICTIONS
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FAIRY RING

This disease is sporadic in occurrence and the severity of symptoms varies from year to year. It can be spread from one bed to another through uprooted vines during wet or dry harvest and their subsequent dislodgment in the next harvested bed. Picking machines should be freed of vines before moving to the next bed. Damage is usually worst during periods of drought; keep vines well-irrigated. Applications of lime during the growing season give limited benefits to the vines and have no effect on the fungal pathogen(s).

MAY	Abound Indar 2F Indar 75 WSP	15.4 oz/30-100 gal 12 oz/30-100 gal 4 oz/30-100 gal	
	Make first application at bud break. Measure ring diameter and add 10 feet to the diameter. Irrigate for 1-2 hours before and following application. Repeat 2-4 weeks later if necessary.		
JUNE - JULY	Ferbam Granuflo	9 lb/100 gal	Apply 1 gal of this mixture to 1 sq ft area. Treat the area 3 feet beyond the advancing line of dying vines and 2 feet within the line. Do not apply after July 31. Only 1 application!
MID-AUGUST THROUGH OCTOBER	Sul-Po-Mag or K-Mag 0-0-22	4000 lb/A or 1.5 oz/sq. ft.	Use alone or after lime to help vines recover. Follow-up applications may be necessary. This may help vines out-compete the fungus.

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DISEASE MANAGEMENT NOTES

1. Read and follow label instructions. Always check label for variations in restricted entry interval and worker protection standards.
2. Make all pesticide applications in a manner to prevent contamination of streams, ponds and public ways. Impound water (as per label) for as long as possible after applying.
3. RESISTANCE DEVELOPMENT to Abound and Indar by the fruit rot fungi is a very real and serious threat. Applications of the fungicide should be made pre-infection rather than post-infection to minimize resistance development. One application of each fungicide is recommended per growing season unless the KQF predicts poor or worse keeping quality. Use Abound very carefully and avoid drift if the bed is next to a McIntosh apple orchard, as the fungicide is highly phytotoxic to this cultivar. See Resistance Management section page iii.
4. REFLOODING for black-headed fireworm control in June is likely to INCREASE FRUIT ROT and MAY SERIOUSLY REDUCE THE CROP.
5. Holding late water will most likely reduce the incidence of fruit rot.
6. PRE-MIX fungicides with a small amount of water until a smooth suspension is obtained before final dilution. Use immediately. Blossom injury may occur with concentrate sprays especially when sprayed by air when the temperature in the bog is above 85°F. Do not combine any copper fungicide with an insecticide. Do not tank mix copper compounds with Aliette unless appropriate precautions have been taken to buffer the spray solution or severe phytotoxicity will result.
7. Consider delaying harvest to obtain acceptable color in thick vines or when Mancozeb or Maneb is used.
8. SANDING and FERTILIZING. Frequent resanding and fertilizing helps reclaim beds infected with false blossom disease. These are accepted IPM practices. Regular uniform sanding most likely helps to reduce inoculum of the fungi that cause fruit rot. Sanding should not be done during the same year late water is to be held.
9. SPREADER STICKERS are contained in most fungicides. The additions of wetting agents or spreader stickers to Bravo, Echo, or Equus may cause phytotoxicity damage. Please check the fungicide label.
10. STORED PESTICIDES may deteriorate. Avoid freezing liquid formulations. It is not advisable to use old materials in opened containers. Follow Pesticide Bureau regulations for disposing of pesticides and their containers.
11. Even if half-rates are used, the maximum number of applications (not material applied) must not be exceeded. It is not recommended that any fungicide application be lower than the lowest recommended rate.
12. Review the Disease Management BMP in the UMass Best Management Practices Guide: <http://www.umass.edu/cranberry/pubs/bmps.html>.
13. Some fungicides are certified organic for disease management in cranberry. They include many of the coppers, OxiDate (128 fl oz/100 gallons of water; apply 25-100 gal/solution/treated acre), and Serenade ASO or MAX, a biofungicide labeled for mummy berry, botrytis, and bacterial canker at 2-6 qts/A.

INSECT MANAGEMENT 2012

Prepared by Anne L. Averill and Martha M. Sylvia

MANAGEMENT GUIDELINES PROVIDED HERE SERVE ONLY AS REMINDERS. FOR MORE COMPLETE INFORMATION, REFER TO
EXTENSION MATERIALS AVAILABLE AT THE CRANBERRY STATION.

MANAGEMENT GUIDELINES

Reducing inputs to cut costs of production. Some key insect management practices should be the last ones eliminated to save money. The following are listed in descending order of importance for most bogs. It is seldom advisable to skip the initial cranberry fruitworm spray (the first spray in IPM-based programs when most pinheads have set and berries have begun to size up) unless late water has been held. This first spray targets the largest portion of the population. Sweep netting in mid-May to detect cranberry weevil, cutworms, gypsy moth, and black-headed fireworm outbreaks is important. It is likely that if insecticide inputs are lowered, black-headed fireworm and weevil levels will increase; *Sparganothis* fruitworm levels should drop. When infestations of weevil or fireworm establish, management inputs must be intensified in subsequent years. Finally, walking the bog early and late in the season to inspect for winter moth larvae, soil insects, mites, and webbing of fireworms allows detection of pests that can affect the acreage in subsequent years or require renovation.

Start scouting bogs early May. Black-headed fireworm and winter moth may be active early but larvae are difficult to see until mid-May. Always gauge levels of pest caterpillars in their early stages! As the caterpillars of many species grow larger, they cling more tightly to the vine or hide in daytime and are harder to pick up in daytime sweep netting. Small black-headed fireworm caterpillars may cling to the top of the net. Some serious pests are active during and after bloom, especially black-headed fireworm, brown spanworm and cranberry weevil, so it is important to continue scouting during and after bloom. Be aware that some pests, particularly cranberry weevil, gypsy moth, black-headed fireworm, and brown spanworm, may be very patchy or in coves or edges, so thorough assessment of total acreage is essential. Many stages of insects are active only at night and are concealed during the day, such as large cutworms, root weevil adults, white grub adults, or some moth species.

Sweep netting. Using a 12" net and 180° sweeps into the vine, sweep netting should be conducted at least once a week. A sweep set consists of 25 sweeps across the bog. The insects in the net should be properly identified, counted, and recorded. Conduct 1 set of 25 sweeps for each acre. For larger pieces (more than 20 acres), at least 1 sweep set/2 acres is advisable. In multiple-acre pieces, calculate the average number of each insect in all of your sweep sets. Treat only after the average numbers of each insect in your series of sweep sets exceeds these values, and after other external concerns have been considered including cost of application, expected returns, weather, etc.

AVERAGE #		AVERAGE #	
ADD UP: blossomworm, false armyworm, other cutworms, and gypsy moth	4.5	black-headed fireworm	1-2
flea beetle	15	<i>Sparganothis</i> fruitworm	1-2
brown spanworm, green spanworm	18	cranberry weevil	4.5 spring 9 summer

In sweep net sampling, the average numbers of a pest that we use to trigger a management measure is only a rule of thumb. It serves as an indication that an insect pest is being sampled at numbers that we consider high and worthy of attention. Significant pressure by cranberry weevil and particularly by black-headed fireworm and *Sparganothis* fruitworm should be attended to in the spring; infestations are harder to manage in the summer.

Pheromone traps. Traps should be used for timing management of cranberry girdler, black-headed fireworm, and *Sparganothis* fruitworm and should be up by June 1. Use 1 trap/10 acres. Place on upwind side of bog. Check and clean traps weekly, recording number of moths captured. Change bait every 3 weeks. Check descriptions of adult moths in extension materials because non-target species are sometimes

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caught. Intrepid and Confirm sprays need to go on several weeks earlier than conventional insecticide sprays (such as Diazinon).

For black-headed fireworm: when treating summer generation with Intrepid or Confirm, apply insecticide 2 weeks after **onset** of moth flight, and again 10 days later. Timing for conventional insecticide is 10 days after **peak** moth flight, usually during bloom.

For Sparganothis fruitworm: if treating with Intrepid or Confirm, apply insecticide 3 weeks after the moth flight **begins**, and again 10-14 days later. Timing for conventional insecticide is 10-14 days after **peak** moth captures, ca. mid-to-late July.

For girdler: treatments are usually in July. Refer to the section on cranberry girdler for timing of specific treatments. Even though trap catches are low, serious larval infestations can exist.

Altacor (diamide-based compound). Altacor is the first insecticide registered in the diamide class of chemistry, and provides a new mode of action compared to all other classes of insecticides. This compound causes paralysis of the insect by sustained contraction of the muscles. It is an excellent fit in IPM programs in that it is a selective insecticide with low toxicity to beneficial arthropods, most importantly, pollinators. In addition to exhibiting excellent activity against our key lepidopteran pests (i.e., cranberry fruitworm and Sparganothis fruitworm), it also has long residual activity and is safe to key mite predators. It is labeled for use at 3.0 to 4.5 oz. per acre. A good chemigation system, under 6 minutes, will likely be necessary to get good efficacy. Ground applications using at least 30 gallons of water per acre, and preferably between 100-150 gallons per acre, may be the most effective applications. This is the pollinator-safe compound we have been waiting for!

Intrepid and Confirm (Insect growth regulator products). Growth regulators are caterpillar-specific and conserve natural enemies and pollinators. These compounds need to be eaten to work. These compounds are most effective when applied multiple times and in low gallonage against small caterpillars feeding on foliage. The best choice is Intrepid, which has higher activity than Confirm, but Intrepid is restricted use and is Zone II restricted. Use aerial application or low-volume ground applications when possible to improve performance. Coverage and well-timed chemigation systems are critical for good efficacy (6 minutes or less rinse time); excessive chemigation washout will remove active material. A spray adjuvant should be used. 6 hours drying time following application is required. New vine growth is not protected. Larval death may not be observed until a week or more has passed. Pollinator safe!

Bacillus thuringiensis (B.t.) based products. Examples include Dipel, Xentari and Biobit. These compounds are most effective when applied multiple times and in low gallonage against small caterpillars feeding on foliage. Well-timed chemigation systems are critical for good efficacy (6 minutes or less rinse time). Thorough coverage is essential and repeat applications may be necessary. *Early attention to infestation is critical.* Caterpillars stop feeding after eating compounds but may take several (3-10) days to die. Use aerial application or low-volume ground applications when possible to improve performance. Addition of a spreader/sticker (e.g., Bond, Stik) may be critical, check label.

Spinosyn-based products include Delegate, SpinTor, and Entrust (an organic formulation). Delegate is the most active and provides longer residual control than SpinTor; Delegate is the compound of choice. Spinosad-based products are fast-acting nerve poisons but are still reduced-risk compounds. Allow 7 days between applications. These compounds are the better choice (compared to Intrepid or Confirm) once the caterpillars have reached a larger size. For Delegate, only use lowered rates if rinse time is 4 minutes or less. For SpinTor, when chemigating, a short rinse time (6 minutes or less) is necessary for good efficacy. Keep in mind that spinosyn products can be toxic to natural enemies. These products are **highly** toxic to bees. Sprays made over bees when they are actively foraging must be avoided (this includes Entrust, even though it is an organic formulation!). However, dried residues are essentially non-toxic. If treating during bloom, be sure that overnight conditions are such that evening chemigation applications will dry by morning.

NOTE: Restricted Use Pesticides (Lorsban, Diazinon, Intrepid, and Actara) A pesticide license (private applicator certification) is required to purchase, handle and apply these compounds to your bog.

BEEES!! MOST INSECTICIDES ARE HIGHLY TOXIC TO BEES, ESPECIALLY DIRECT APPLICATIONS AND RESIDUES. DO NOT APPLY OR ALLOW TO DRIFT TO CRANBERRIES IN BLOOM OR NEARBY BLOOMING PLANTS/WEEDS IF BEES ARE FORAGING. REMOVE HONEY BEE HIVES OR ADVISE BEEKEEPER IF SPRAYS ARE APPLIED. REMEMBER THAT NATIVE WILD BEES, SUCH AS BUMBLE BEES, ARE ALSO VULNERABLE TO SPRAYS APPLIED AT BLOOM AND THAT POPULATIONS WILL DWINDLE OVER TIME IF THEY ARE NOT PROTECTED.

EARLY SEASON CATERPILLARS

CUTWORMS (BLOSSOMWORM, FALSE ARMYWORM) and HUMPED GREEN FRUITWORM

Bolded selections are the best choices for management. All rates are per acre.

Dipel ES	1-4 pt	<u><i>Bacillus thuringiensis</i> (B.t.) products.</u> Multiple applications, addition of an adjuvant, and good coverage in low gallonage are essential.
Biobit	0.5-2 lb	
Xentari	0.5-2 lb	

Target larvae when small. Safe for pollinators and natural enemies.

Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between applications. Delegate is more active and has greater residual than SpinTor. Only use lowered rates if rinse time is 4 minutes or less.
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SpinTor 2SC (spinosad)	4-10 fl oz	Do not exceed 29 oz/season. 7 days between applications. For SpinTor, a short rinse time (6 minutes or less) is necessary.
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Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation. Hold water for at least 3 days. 5 day REI!! 3 apps/season, 7-day PHI, and 14-day spray interval, except AG500 which has a 7-day minimum.
Diazinon AG 500	2-3 qt	
Diazinon AG 600	51-76.5 fl oz	

Intrepid 2F	10-16 fl oz	Insect growth regulator products, these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note, however, Intrepid is restricted use and Zone II restricted. See product discussion on page 8. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	

Late Water False armyworm and blossomworm may be managed with late water. See page 59.

Lorsban 4E, Nufos 4E	1.5-3 pt	Rates as low as 1.5 pts (aerial) or 2 pts (chemigation) are reported to give satisfactory control. 2 apps/season. Do not mix with other insecticides. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use.
Chlorpyrifos 4E AG	1.5-3 pt	
Lorsban Advanced, Hatchet	3 pt	
Lorsban 75 WG	2 lb	

Orthene 97, Acephate 97, 97UP	1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 application/season. Observe 90-day PHI, except 75-day PHI with some Acephate 90, 97, 97UP only – check label.
Acephate 90 WSP, 90 WDG	1.1 lb	
Acephate 90 Prill	1.1 lb	

Sevin XLR Plus	2 qt	5 applications/season, 7-day spray interval, 7-day PHI.
Sevin 4F, Carbaryl 4L	2 qt	
Sevin 80S (Solupak)	2.5 lb	

The action threshold for cutworms is an average of 4.5 larvae per 25 sweeps. Count all cutworms and gypsy moths together. Very young false armyworm caterpillars are whitish with black spots, each with a black spine. These caterpillars tend to loop like spanworms but gradually drop this movement. Early detection is important because they consume the terminal buds before new growth starts. As cutworms get older, they will not be picked up in day sweeps. Night sweeps may be required to gauge infestation at that point.

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SPANWORMS (GREEN SPANWORM, BROWN SPANWORM, BIG CRANBERRY SPANWORM, WINTER MOTH)

Bolded selections are the best choices for management. All rates are per acre.

Altacor	3-4.5 oz	See product discussion on page 8, new chemistry. Low rinse time required for efficacy. Do not exceed 9 oz/season. 7 days between applications.
Avaunt	6 oz	7 days between applications, no flow-through bogs, hold water 1 day.
Dipel ES	1-4 pt	<u>Bacillus thuringiensis (B.t.) products.</u> Multiple applications, addition of an adjuvant, and good coverage in low gallonage are essential.
Biobit	0.5-2 lb	
Xentari	0.5-2 lb	Target larvae when small. Safe for pollinators and natural enemies.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between applications. Only use lowered rates if rinse time is 4 minutes or less.
SpinTor 2SC (spinosad)	4-10 fl oz	Do not exceed 29 oz/season. 7 days between applications. For SpinTor, a short rinse time (6 minutes or less) is necessary.
If infestation appears during bloom, remember these compounds are highly toxic to bees, but that dried residues are non-toxic; thus, sprays must go on at night and dry by morning.		
Intrepid 2F	10-16 fl oz	Insect growth regulator products, these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note, however, Intrepid is restricted use and Zone II restricted. See product discussion on page 8. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	
Imidan 70W	1.33-4 lb	Efficacy may be reduced at pHs found in bog water (pH 6-7). REI of 3 days, 10-day spray interval, 14-day PHI. Beware bee toxicity.
Lorsban 4E, Nufos 4E	1.5-3 pt	<u>Poor choice for most bogs,</u> nearly all populations are resistant. Limit 2 apps/season. Do not mix with other insecticides. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use.
Chlorpyrifos 4E AG	1.5-3 pt	
Lorsban Advanced, Hatchet	3 pt	
Lorsban 75 WG	2 lb	
Orthene 97, Acephate 97, 97UP	1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 application/season. Observe 90-day PHI, except 75-day PHI with some Acephate 90, 97, 97UP only – check label.
Acephate 90 WSP, 90 WDG	1.1 lb	
Acephate 90 Prill	1.1 lb	
Pyganic EC 1.4	16-64 fl oz	Spot treating using low gallonage may be helpful for patchy infestations. Beware bee toxicity – do not apply when bees are present.
Pyganic EC 5.0	4.5-18 fl oz	

For green and brown spanworm, the action threshold is an average of 18 small larvae in 25 sweeps. Threshold may be lowered for large larvae. ***Be aware of brown spanworm infestations during bloom*** that may be patchy. Newly hatched brown spanworms cling like thin threads to the inside of the net. For big cranberry spanworm, the action threshold is 4.5 in 25 sweeps. As spanworms get older, they will not be picked up in day sweeps.

Green spanworm caterpillars start to appear in early season sweeps; brown spanworm caterpillars appear later. A flight of brown moths in June may be an indication of a brown spanworm problem but only target caterpillars with sprays! Big cranberry spanworms appear in mid-June. They can be very destructive, occurring in patches. Caterpillars are dark brown with bumps across their back and grow to 2.5" in size. Spot treating may work.

Scout for winter moth much earlier than other spanworms. Winter moth is a spanworm species and is likely present as early as May 1. If you have a history of winter moth infestation, you may need to apply a prophylactic spray early in the season. Populations may reoccur as larvae balloon in. Injury may be done to the developing tips before populations can be detected.

Other miscellaneous spanworms appear in patches and grow larger than the common green and brown spanworm, so it may be advisable to lower the action threshold by half if these infestations occur.

BLACK-HEADED FIREWORM

Bolded selections are the best choices for management. All rates are per acre.

Altacor	3-4.5 oz	New chemistry. Low rinse time required for efficacy. See product discussion on page 8. Do not exceed 9 oz/season. 7 days between applications.
Avaunt	6 oz	7 days between applications. 30-day PHI. No flow-through bogs, hold water 1 day.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between applications. Delegate is more active and has greater residual than SpinTor. Only use lowered rates if rinse time is 4 minutes or less.
SpinTor 2SC (spinosad)	4-10 fl oz	Do not exceed 29 oz/season. 7 days between applications. For SpinTor, a short rinse time (6 minutes or less) is necessary.
Diazinon 50 W	4 lb	It is advisable to hold water for at least 3 days. 5-day REI!! 3 applications/season, 7-day PHI, and 14-day spray interval, except AG500 which has a 7-day spray interval.
Diazinon AG 500	2 qt	
Diazinon AG 600 WBC	51 fl oz	
Imidan 70W	1.33-4 lb	Efficacy may be reduced at pHs found in bog water (pH 6-7). REI 3 days, 10-day spray interval, 14-day PHI.
Intrepid 2F	10-16 fl oz	Insect growth regulator products; these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note however, Intrepid is restricted use and Zone II restricted. See product discussion on page 8. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	
Lorsban 4E, Nufos 4E	1.5-3 pt	Rates as low as 1.5 pts (aerial) or 2 pts (chemigation) are reported to give satisfactory control. 2 apps/season. Do not mix with other insecticides. Observe 60-day PHI. Impound water for 5 days, then release gradually. Note: 75 WG formulation is not restricted use.
Chlorpyrifos 4E AG	1.5-3 pt	
Lorsban Advanced, Hatchet	3 pt	
Lorsban 75 WG	2 lb	
Orthene 97, Acephate 97, 97UP	1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 application/season. Observe 90-day PHI, except 75-day PHI with some Acephate 90, 97, 97UP only – check label.
Acephate 90 WSP, 90 WDG	1.1 lb	
Acephate 90 Prill	1.1 lb	
Sevin XLR Plus	1.5-2 qt	5 applications/season, 7-day spray interval, 7-day PHI.
Sevin 4F, Carbaryl 4L	1.5-2 qt	
Sevin 80S (Solupak)	1.88-2.5 lb	

Watch out: Fireworm can be a very serious problem! *Best approach is to start inspecting in early spring*—pest is easy to manage if infestation is detected early. Larvae hatch in mid-May; even earlier in warm springs. While sweeping in May, look for very small, hard-to-see larvae on the net rim. Small larvae are less likely to be picked up in the net than larger larvae. Infestations are often patchy and more numerous along edges, where vines are overgrown, where leaf trash has accumulated, or where winter flooding was withdrawn early. Spot treatment is desirable here.

2nd generation is active during bloom. Use pheromone traps to time management of 2nd generation. Black-headed fireworm moths are only 1/4" long and are black and gray; be aware that the pheromone trap often picks up a much larger, non-pest moth. When treating summer generation with growth regulators (Intrepid or Confirm), timing is 2 weeks after **onset** of moth flight, and again 10 days later. For other insecticides, such as Diazinon, Delegate, or Avaunt, apply insecticide 10 days after **peak** moth flight, usually during bloom. Choosing these insecticides during bloom will interfere with pollination.

Infestations move rapidly! Spring generation is a much easier target than the second generation (occurs during bloom).

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YELLOW-HEADED FIREWORM

Lorsban, Orthene, Sevin, and spinosyn products (**Delegate**, SpinTor, and Entrust) can be used as specified for black-headed fireworm (see page 11).

Intrepid and **Diazinon**, FIFRA 2EE recommendations, can be used as specified for black-headed fireworm (page 11).

Yellow-headed fireworm may appear on beds that are not completely flooded in the winter. Eggs hatch in May. Caterpillars are all yellow and are impossible to distinguish from Sparganothis. It is often the case that totally winter-flooded beds have Sparganothis and partially, poorly winter-flooded beds, have yellow-headed fireworm. The yellow-headed fireworm pupa has a knob at its top, which Sparganothis pupae do not.

SPARGANOTHIS FRUITWORM

Bolded selections are the best choices for management. All rates are per acre.

*** indicates restrictions from handlers. Please check with handler before using.**

* Altacor	3-4.5 oz	See product discussion on page 8, new chemistry. Low rinse time required for efficacy. Do not exceed 9 oz/season. 7 days between applications.
*Assail 30 SG	4.0-6.9 oz	7 days between apps, 2 apps. Handler restrictions, use with caution.
Delegate WG (spinetoram)	3-6 oz	Do not exceed 19.5 oz/season. 7 days between applications. Delegate is more active and has greater residual than SpinTor. Only use lowered rates if rinse time is 4 minutes or less.
SpinTor 2SC (spinosad)	4-10 fl oz	Do not exceed 29 oz/season. 7 days between applications. For SpinTor, a short rinse time (6 minutes or less) is necessary.
Intrepid 2F	10-16 fl oz	Insect growth regulator products, these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note, however, Intrepid is restricted use and Zone II restricted. See product discussion on page 8. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	
*Lorsban 4E, Nufos 4E	1.5-3 pt	<u>Poor choice for most bogs</u> , nearly all populations are resistant.
*Chlorpyrifos 4E AG	1.5-3 pt	Limit 2 apps/season. Do not mix with other insecticides.
*Lorsban Advanced, Hatchet	3 pt	Observe 60-day PHI. Impound water for 5 days, then release gradually.
*Lorsban 75 WG	2 lb	Note: 75 WG formulation is not restricted use.
*Orthene 97, Acephate 97UP	1 lb	<u>Poor choice for most bogs</u> , nearly all populations are resistant.
*Acephate 90 WSP, 90 WDG	11.1 lb	Do not apply within 10 days of start of bloom due to bee concerns.
*Acephate 90 Prill	1.1 lb	90-day PHI except 75-day PHI with some Acephate formulations.

Small Sparganothis caterpillars are picked up in the sweep net in mid-May. Check for caterpillars in yellow loosestrife weed tips that have rolled leaves; this will give you an idea of the larva's appearance so you can ID them in the net. The 2nd generation in July feeds on both fruit and foliage. With both generations, always target the small caterpillars. Keep an eye on Ben Lear, which tend to be hardest hit; Howes the least. The 2nd generation feeding on Ben Lear develop faster and may feed inside the fruit.

Beginning in June, use pheromone traps to determine moth flight. When managing a population, you want to target caterpillars as they are hatching, not the adult moths. If treating with growth regulators (Confirm or Intrepid), apply insecticide earlier in the moth flight; 3 weeks after the moth flight begins, ca. early July, and make at least one more application 10-14 days later. When treating with other insecticides, such as Delegate, apply 10-14 days after peak moth captures, ca. mid-to-late July.

Nearly all Sparganothis populations are resistant to Lorsban and Orthene. Intrepid and Delegate are excellent alternatives and good choices. Late water has not been shown to be effective against this insect, but it does synchronize moth emergence.

GYPSY MOTH

Bolded selections are the best choices for management. All rates are per acre.

*** indicates restrictions from handlers. Please check with handler before using.**

*Assail 30 SG 4.0-6.9 oz 7 days between apps, 2 apps maximum.

Bacillus thuringiensis (B.t.) products See discussion under cutworm or spanworm (pages 9 and 10).

Intrepid 2F	10-16 fl oz	Insect growth regulator products, these compounds need to be eaten to work. Intrepid is more active and has greater residual than Confirm. Note, however, Intrepid is restricted use and Zone II restricted. See product discussion on page 8. Safe for pollinators and natural enemies.
Confirm 2F	16 fl oz	

Late Water Holding late water kills eggs laid on the bog as well as prevents establishment of tiny caterpillars that drift in from infested uplands. See Late Water section.

*Orthene 97, Acephate 97, 97UP	1 lb	Do not apply within 10 days of start of bloom due to bee concerns. 1 application/season. Observe 90-day PHI, except 75-day PHI with some Acephate 90, 97, 97UP only – check label.
*Acephate 90 WSP, 90 WDG	1.1 lb	
*Acephate 90 Prill	1.1 lb	

*Sevin XLR Plus	1.5-2 qt	5 apps/season, 7-day spray interval.
*Sevin 4F, Carbaryl 4L	1.5-2 qt	
*Sevin 80S (Solupak)	1.88-2.5 lb	

Insecticides (Diazinon, **Delegate**) applied for cutworms or spanworms may provide control. Action threshold is an average of 4.5 larvae/25 sweeps. Check for patchy infestations and spot treat, i.e., along edges facing uplands with infested trees. Check previously infested areas -- eggs can overwinter on flooded bogs. Early detection is key; larvae consume terminal buds before new growth starts.

CRANBERRY WEEVIL

Actara (thiamethoxam) 2-4 oz Effective against both spring and summer adult populations. Lower rates effective. Restricted Use and Zone II restricted. Do not apply by air or to flow-through bogs. Highly toxic to bees – do not apply within 5 days of bee arrival. Hold water 5 days.

***Belay** (clothianidin) 4 fl oz Use only for summer adult populations after bees are gone. Highly toxic to bees, more than 5 days after treatment!. 12-hr REI, 21-day PHI. If you use Belay for weevil, you cannot use it for soil application. Total amount allowed is 12 oz. Beware, handler restrictions.

Avaunt (indoxacarb) 6 oz Effective against spring weevil populations only. Do not use after bloom against weevil in summer. Only 2 apps allowed targeting weevil in spring, prior to bloom. 7 days between applications. No flow-through bogs, hold water 1 day. Toxic to bees.

Lorsban 4E, Nufos 4E	1.5-3 pt	Poor choice for most bogs, many populations are resistant. 60-day PHI. Impound water for 5 days, then release slowly. Note: 75 WG formulation is not restricted use. Toxic to bees.
Lorsban Advanced, Hatchet	3 pt	
Lorsban 75 WG	2 lb	

Action threshold is an average of 4.5 weevils in 25 sweeps for spring population, and 9 weevils in summer. Summer feeding is not as damaging as spring feeding and egg-laying. Adult weevils are found throughout the growing season. See sweep netting section page 7. Sweep when warm, sunny, and calm. Let net contents settle: weevils "play dead" when disturbed. Do not count non-pest gray weevils. Spring weevils move in from outside bog; consult sweep records from previous years to determine invasion pattern. Even if threshold is exceeded, sometimes it is advisable to wait 1-2 wks in spring to treat. Weevil numbers may continue to rise as more weevils move in. However, waiting too long becomes risky if blossom buds have appeared and eggs are being laid. Late water is not effective against weevil.

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CRANBERRY FRUITWORM

Bolded selections are the best choices for management. All rates are per acre.

*** indicates restrictions from handlers. Please check with handler before using.**

For most bogs, a properly timed first cranberry fruitworm spray is the most important one of the season.

*Altacor	3-4.5 oz	See product discussion on page 8, new chemistry. Low rinse time required for efficacy. Do not exceed 9 oz/season. 7 days between applications. Bee safe! Recommended for first fruitworm at 50% out of bloom but only on early cultivars and where pressure has generally been moderate to heavy!
*Assail 30 SG	4.0-6.9 oz	7 days between applications, 2 apps maximum, 1-day PHI. Toxic to bees.
Delegate WG (spinetoram)	3-6 oz	FIFRA 2EE recommendation. Do not exceed 19.5 oz/season. Highly toxic to bees, but thoroughly dried residues are safe. Thus, sprays must go on at night and dry by morning if sprayed during bloom
Diazinon 50 W	4-6 lb	Toxic to bees. It is advisable to hold water for at least 3 days.
Diazinon AG 500	2-3 qt	5 day REI!! 3 applications/season, 7-day PHI, and 14 days between
Diazinon AG 600 WBC	51-76.5 oz	sprays, except AG500 which has a 7-day minimum.
*Imidan 70W	1.33-4 lb	Toxic to bees. Efficacy results have been very variable. If chosen, use higher rate. Efficacy may be reduced at pHs found in bog water (pH 6-7). REI of 3 days, 10-day spray interval, 14-day PHI.
Intrepid 2F	10-16 fl oz	FIFRA 2EE recommendation. Zone II restricted. Ground applications <u>only</u> are highly effective. Chemigation gives moderate to good level of control in well-timed systems. Safe for bees and natural enemies.
Late Water	Holding late water is an excellent choice as it severely reduces fruitworm. However, moths may move into late water-treated beds from other areas of infestation, so it is advisable to spot check for eggs. Refer to Late Water Practice on next page.	
*Lorsban 4E, Nufos 4E	1.5-3 pt	Toxic to bees. 2 apps/ season. Handler restrictions, beware.
*Lorsban Advanced, Hatchet	3 pt	Observe 60-day PHI. Impound water for 5 days, then release slowly.
*Lorsban 75 WG	2 lb	Note: 75 WG formulation is not restricted use.
*Sevin XLR Plus	1.5-2 qt	Toxic to bees. Sevin XLR Plus is formulated to have minimal
*Sevin 4F, Carbaryl 4L	1.5-2 qt	bee toxicity once the spray dries. Limit of 5 applications/season,
*Sevin 80S (Solupak)	1.88-2.5 lb	7-day spray interval, 7-day PHI. Handler restrictions, beware.

CRANBERRY FRUITWORM MANAGEMENT

FOR ALL PRACTICES

1. Every pump system should be scouted separately as one piece.
2. To be valid, sampling of berries by size and bog area must be random because moths select larger berries particularly along bog margins and inner ditches.
3. Use a magnifier to look for eggs. Look at eggs carefully to be sure they are alive. As you move into the season, many eggs are dead or parasitized. Do not count these.
4. Target only eggs. Do not treat in attempt to control caterpillars in the fruit. Research shows that sprays made after caterpillars have entered fruit are minimally effective.
5. For beds with very high fruitworm pressure and large fruited varieties, it may be cost effective to apply Intrepid 2F in lowest water gallonage/acre even before or at 50% out-of-bloom. There is no risk to pollinators with this compound.
6. Timing first spray using % out of bloom: In the event of unusually warm or cool weather during fruit set it is advisable to shorten or lengthen accordingly the interval between 50% out-of-bloom and the first spray.
7. It is not necessary or desirable to mix compounds for effective control.

STANDARD PRACTICE**1st TREATMENT - CALCULATE % OUT-OF-BLOOM** (# of blossoms that have lost petals or become fruits)

To properly time your first spray, you must calculate the % out-of-bloom every couple of days as pinheads start to form, usually around the end of June. You are trying to accurately assess when 50% OOB occurs. For each acre of bog, randomly collect 10 uprights and record the number of pods, flowers, pinheads, and fruit. Calculate using the following:

$$\% \text{ out-of-bloom} = \frac{\text{total number of pinheads and fruit}}{\text{total number pods, flowers, pinheads, and fruit}} \times 100$$

For Howes -- Apply 1st treatment 7-9 days after 50% out-of-bloom.

For Early Blacks, Ben Lears and Stevens -- Apply 1st treatment 0-7 days after 50% out-of-bloom.

Timing of this spray is critical. If fruitworm pressure has been high in previous years and berries are sizing up, spray should occur very soon after 50% OOB in early cultivars. Delegate, sprayed only at night when residues can be dried by morning, is the compound of choice for during-bloom sprays. Keep in mind that all insecticides, with the exception of the growth regulators (Confirm and Intrepid), are toxic to bees.

2nd TREATMENT - Apply 2nd treatment about 10 days after 1st treatment.

ADDITIONAL TREATMENTS - MONITOR EGGS TO TRIGGER SPRAYS

One week after your 2nd treatment, inspect 50 randomly picked berries/A (with a minimum of 200 berries per piece, no matter how small piece is) for viable eggs. Follow guidelines in table below to determine necessity of additional sprays. If egg numbers trigger a spray, spray ASAP. If no egg is found, repeat berry inspection process every 3-4 days until Aug. 15 or longer if eggs are still being detected.

SCOUTING PRACTICE**1st TREATMENT - CALCULATE % OUT-OF-BLOOM** (# of blossoms that have lost petals or become fruits)

Apply 1st treatment 7-9 days after 50% out-of-bloom (half the blossoms have lost all petals or become fruits) for Howes and apply 0-7 days after 50% out-of-bloom for Early Blacks, Ben Lears, and Stevens. ***If fruitworm pressure has been high in previous years and berries are sizing up, spray timing is critical and should not be delayed long after 50% OOB has been reached.***

ADDITIONAL TREATMENTS USING SCOUTING PRACTICE

Five days after treatment, inspect 50 randomly picked berries/A (with a minimum of 200 berries per piece) for eggs. Follow guidelines in table below to determine necessity of additional sprays. If egg numbers trigger a spray, spray ASAP. If no egg is found, repeat berry inspection process every 3-4 days until Aug. 15.

LATE WATER PRACTICE

Late water may effectively reduce fruitworm pressure. It is possible that sprays can be eliminated for cranberry fruitworm but berries must be monitored for eggs throughout the fruitworm season as the moths are very mobile and may move into your bog from external sources.

TREATMENTS - MONITOR EGGS TO TRIGGER SPRAYS

As fruits set, begin inspecting 50 randomly picked berries/A (with a minimum of 200 berries per piece) for eggs. Follow guidelines in table below to determine necessity of spray. If egg numbers trigger a spray, spray ASAP. If no egg is found, repeat berry inspection process every 3-4 days until Aug. 15. If fruitworm pressure is low through fruit set, it may be safe to extend intervals between berry sampling dates.

TABLE USED (for all practices) TO DETERMINE NECESSITY OF MAKING A SPRAY

Number of acres	Number of berries checked	Number of viable eggs needed to trigger spray
0-5	200-250	1
5-7	251-350	2
7-9	351-450	3
9-11	451-550	4
11-13	551-650	5
13-15	651-750	6
for each additional 2 acres	add 100 berries	add 1 egg

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SOIL INSECTS

BLACK VINE WEEVIL AND STRAWBERRY ROOT WEEVIL

Nematodes	Availability limited—need to plan ahead and order well in advance of application. Target immatures in soil. Apply in early evening in May and/or September. Best results occur when soil temperatures are higher than 56°F. Irrigate before and after application. Chlorpyrifos (e.g., Lorsban) has been reported to adversely affect nematodes.
Fall Flood	Flood for 10-14 days as soon as possible after harvest. May also negatively impact vines to some degree. Warmer water enhances effectiveness.
Winter Flood	If you can winter flood, populations should be less abundant.

In the spring, look for grubs in soil associated with areas of dying vines (often near bog edge) that may have an orange halo of vines around edges. Grubs feed on the bark of the vine. Adult beetles emerge in June; they must feed for about 4 weeks before egg-laying starts. Night sweep for weevils at edge of weevil-damaged areas, starting after dusk but before dew forms in mid-June through July. Notched new foliage indicates adult feeding. Sweep when vines are dry. These pests are more abundant in bogs with no winter flooding or high spots.

SCARAB GRUBS

Admire Pro	7-14 fl oz	Imidacloprid products, rate per acre. Use soil drench treatment for oriental beetle. May suppress cranberry root grub and cranberry white grub, but data are lacking and multiple years likely required to see effect. Limit 2 apps/season <u>but 1 app at higher rate is recommended</u> . No aerial app, 30-day PHI. <i>Best results are achieved when the compound is present just prior to egg hatch—this can be determined by monitoring oriental beetle flight with pheromone traps starting in late June-early July. Application should be made 3 weeks after peak flight of the beetles (or slightly earlier).</i> Irrigate before and after application, but do not apply to saturated soil. Compound has very long soil residual. Highly toxic to bees; do not apply when pollinators are on bog.
MANA Alias 4F	8-16 fl oz	
Admire 2F	16-32 fl oz	
Alias 2F	16-32 fl oz	
Widow	16-32 fl oz	

*Belay (clothianidin) 12 fl oz Highly toxic to bees. Apply as a soil drench only after bees have been removed or all bloom gone. 12-hr REI, 21-day PHI. If you use Belay as a soil drench, you cannot use it as a foliar application on weevil, flea beetle or fruitworm. Total amount allowed is 12 oz.
*Handler restrictions, check with handler before using.

Summer flood Remove winter flood and allow bog to dry out. Reflow mid-May and keep well flooded until mid-July. This will eliminate cranberry root grub and cranberry white grub larvae, as well as the crop for that year. Oriental beetle and *Hoplia* are probably also impacted by the summer flood.

Cranberry root grub - grubs turn into low-flying beetle adults that look like bumblebees; they emerge from the soil during cranberry bloom and set. Males fly after dawn through mid-morning.

Cranberry white grub - grubs turn into large-bodied "June bugs" as adult beetles and are active in the evening in May and June.

Oriental beetle - small beetle (5/8 inch), vary greatly in color and pattern from light brown to black. Grubs develop over two years and are similar in appearance to small white grubs. An adult sex pheromone trap is available.

Hoplia equina - adult beetles emerge synchronously from the soil during bloom in late afternoon. The small brown beetles are about 5/16 inch in size. The grubs develop over two years and are similar in appearance to small white grubs.

In the spring, look for grubs in both root layer and lower soil associated with areas of weak or dying vines. Because it is unknown if Oriental Beetle and *Hoplia* respond to summer flooding, let us know if you summer flood for these species. In grub-infested areas, try to avoid stress to vines such as high doses of Casoron and drought. For *Hoplia* only, there is some evidence of nematode efficacy. Call the Cranberry Station for additional advice

CRANBERRY GIRDLER

Nematodes	Availability limited—need to plan ahead and order well in advance of application. Apply Nematodes 2 weeks after end of moth flight. Target immatures in soil.
Fall Flood	Flood for a week as soon as Early Blacks are harvested, starting no later than Sept. 25. Vines must be completely covered. It may be necessary to flood late varieties with berries on the vine. May also negatively impact vine health to some degree.
Regular Sanding	Sanding with 1-3 inches every 3rd year will reduce favorable girdler habitat.

In June through July, appearance of silvery-white moths with a "snout" on front of head that make short, jerky flights as you walk through the vines may signal a problem, but be sure to target immatures in soil with control treatment. If there is a history of girdler on your bog, use pheromone traps to time treatments. Be aware of girdler's true appearance; a very similar non-pest moth is also picked up in traps. A bad girdler infestation can exist even with low pheromone trap catches. Just below the trash line, look for old feeding damage that may be quite deep in the wood of the vine. Thorough trash flows are beneficial.

STRIPED COLASPIS

Admire Pro	7-14 fl oz	Imidacloprid products. Soil drench <u>targets immatures</u> in soil. When adult beetles are picked up in net, application should be made to target larvae as eggs hatch. Compound has very long soil residual. No aerial application. Limit 2 apps/season, but <u>1 app at higher rate is recommended</u> . Irrigate before and after application. Highly toxic to bees; apply after bloom in mid-late July. 30-day PHI.
MANA Alias 4F	8-16 fl oz	
Admire 2F	16-32 fl oz	
Alias 2F	16-32 fl oz	
Widow	16-32 fl oz	
*Belay (clothianidin)	12 fl oz	Highly toxic to bees. Apply as a soil drench targeting immatures in the soil only after bees have been removed or all bloom gone. 12 hr REI, 21 day PHI. If you use Belay as a soil drench, you cannot use it as a foliar application on weevil, flea beetle or fruitworm. Total amount allowed is 12 oz. *Handler restrictions, check with handler before using.
Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation <u>targets adults</u> . It is advisable to hold water for at least 3 days. Check labels; most are 3 apps/season, 5-day REI, 7-day PHI, 14-day spray interval, except AG500 which has 7-day minimum.
Diazinon AG 500	2-3 qt	
Diazinon AG 600 WBC	51-76.5 fl oz	
*Sevin XLR Plus	1.5-2 qt	FIFRA 2EE recommendation <u>targets adults</u> . Do not apply when bed is in bloom. 5 apps/season, 7-day spray interval, 7-day PHI. *Handler restrictions, check with handler before using.
*Sevin 4F & Carbaryl 4L	1.5-2 qt	
*Sevin 80 WSP & 80S	1.88-2.5 lb	

Imidacloprid (Admire/Alias) and Belay should target hatching eggs in the soil. Diazinon and carbaryl (Sevin) sprays should target adults being picked up while sweep netting. Highly toxic to bees; advise beekeepers to remove or cover hives before application; these daytime applications will kill native bees foraging during bloom. The beetles are ca. 1/6" long and oblong-oval. Head area is metallic greenish-black and wings blackish, striped with yellow. Legs and antennae are yellow.

Grubs in soil feed in root area, killing vines. Adult feeding results in distinct notching in top leaves of uprights, particularly in infested area.

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MISCELLANEOUS PESTS

CRANBERRY TIPWORM

Early season tipworm injury often is high, but good vine health enhances rebudding. Appearance of injury does not mean that insects are still present. Only very late-season injury, which is rare, appears to consistently reduce yield. Stressful vine conditions in the year of injury may also result in yield reduction. Diazinon is labeled for tipworm, but control is very poor. Sprays are strongly discouraged for this insect.

CRANBERRY FLEA BEETLE

Bolded selections are the best choices for management. All rates are per acre.

*** indicates restrictions from handlers. Please check with handler before using.**

Actara	2-4 oz	May provide suppression of flea beetle only. Restricted Use and Zone II Do not apply by air or to flow-through bogs. Hold water 5 days!
*Belay (clothianidin)	4 fl oz	Foliar applications targeting adults. Highly toxic to bees and foliage is toxic for more than 5 days after application. Use only after bees are removed or bloom is complete. If you use Belay as a foliar application, you cannot use it for a soil application. Total amount allowed is 12 oz.
OR		
*Belay (clothianidin)	12 fl oz	Post-bloom application - apply as a soil drench targeting immatures in soil after adults were seen. Highly toxic to bees. 12-hr REI, 21-day PHI. If you use Belay as a soil drench, you cannot use it as a foliar application on weevil, flea beetle or fruitworm.
Delegate WG	3-6 oz	FIFRA 2EE recommendation. Delegate may provide suppression of flea beetle only. Do not exceed 19.5 oz/season. 7 days between applications.
*Sevin XLR Plus	1.5-2 qt	5 applications/season, 7-day spray interval, 7-day PHI.
*Sevin 4F, Carbaryl 4L	1.5-2 qt	
*Sevin 80S (Solupak)	1.88-2.5 lb	
Diazinon 50 W	4-6 lb	FIFRA 2EE recommendation. Hold water for at least 3 days.
Diazinon AG 500	2-3 qt	Check labels; most are 3 apps/season, 5-day REI, 7-day PHI, and
Diazinon AG 600 WBC	51-76.5 fl oz	14-day spray interval, except AG500 which has a 7-day minimum.

Adult flea beetles are active in late July through September. Beetles and their feeding injury are very patchy, often in areas of lush vine. High levels of beetle feeding can impact bud development for the following year. Firm thresholds have not been quantified, but sweep net counts of 15 per 25 sweeps on average over all acreage is the current rule of thumb.

SOUTHERN RED MITE (SRM)

Nexter	3.5-7.0 oz	2 apps/season. Ground and chemigation only – no aerial application. Hold water for 3 days after application. No flow-through bogs. 5 hours of drying time required.
*Oberon	12-16 fl oz	FIFRA 2EE recommendation, but efficacy data are needed for SRM. Apply by ground and chemigation only – no aerial application. Hold water 1 day after app, 12-hr REI.
Late Water		Research shows that late water can eliminate mites in the year that the flood is held. In the second year following late water, mite pressure may still be low. See Late Water Section.

Look for tiny red mites in sweep net and for red/orange streaks on rim of net or white card. Use a 10X magnifier to examine leaves to determine that mites are present; misidentifications frequently occur. Areas of discolored vines late in the season are often an indicator of mite infestation.

MANAGEMENT NOTES FOR ALL INSECT RECOMMENDATIONS

1. **READ AND FOLLOW LABEL INSTRUCTIONS.** Do not use a pesticide for control of a pest not on the label unless a specific recommendation is made by a person authorized to do so (FIFRA 2EE). Pesticide-treated bogs may need to be posted. Check labels. Workers and scouts should be notified prior to treatments and informed about re-entry times. See label for variation in restricted entry times and worker protection standards (WPS). **ONLY APPLY INSECTICIDES IF DAMAGING NUMBERS ARE PRESENT – DETERMINE THIS BY SCOUTING EACH BED.**

2. **LATE WATER** -- See Late Water section for more details. Late water research shows that the flood severely reduces mites, cranberry fruitworm, false armyworm, blossomworm, and gypsy moth.

3. **REFLOODING OPTIONS** –

- a) About May 18th for 10 hours controls false armyworm and blossomworm.
- b) About June 1-12th for 10 hours controls green spanworm, small black-headed fireworm, spotted and black cutworms and armyworms, but is likely to **increase fruit rot** and **seriously reduce the crop**.
- c) About May 12th and holding up to July 15-20th kills all insects, but with the loss of crop.
- d) Sept. 20-30th. Flooding within this time for a week every third year discourages girdler and blossomworm. A 3 or 4 week flood at this point will manage cranberry fruitworm. These floods are best done when fruits have been removed. Research shows that this flood timing may negatively impact vine health.

4. **SANDING** -- Regular uniform sanding helps check girdler and green spanworm.

5. **LEAFMINERS** -- There is no evidence that available registered insecticides control these insects.

6. **FOR COMPLETE GUIDELINES** – Management guidelines provided here serve only as reminders. Review the Insect Management BMP in the UMass Best Management Practices Guide:

<http://www.umass.edu/cranberry/pubs/bmps.html>.

7. BEES!! MOST INSECTICIDES ARE HIGHLY TOXIC TO BEES, ESPECIALLY DIRECT APPLICATIONS AND RESIDUES. DO NOT APPLY OR ALLOW TO DRIFT TO CRANBERRIES IN BLOOM OR NEARBY BLOOMING PLANTS/WEEDS IF BEES ARE FORAGING. REMOVE HONEY BEE HIVES OR ADVISE BEEKEEPER IF SPRAYS ARE APPLIED. REMEMBER THAT WILD BEES, SUCH AS BUMBLE BEES, ARE ALSO VULNERABLE TO SPRAYS APPLIED AT BLOOM AND THAT POPULATIONS WILL DWINDLE OVER TIME IF THEY ARE NOT PROTECTED.

INSECTICIDE TOXICITY TO HONEYBEES		
Admire	imidacloprid	super toxic
Actara	thiamethoxam	
Belay	clothianidin	
Nexter	pyridaben	
Delegate	spinetoram	
SpinTor/Entrust	spinosad	
Lorsban	chlorpyrifos	highly toxic
Avaunt	indoxacarb	
Diazinon	diazinon	
Imidan	phosmet	
Orthene	acephate	
Sevin	carbaryl	
Altacor	chlorantraniliprole	practically non-toxic
Assail	acetamiprid	
Intrepid	methoxyfenozide	
Confirm	tebufenozide	

20 Insects

ORGANIC OPTIONS FOR INSECT MANAGEMENT

Organic production may not be a profitable option unless there is low-moderate insect pressure and a good water supply. Cranberry fruitworm, black-headed fireworm and cranberry weevil pose the greatest threats to viability.

Growers who wish to be certified by an organic certification organization need to go through *Bay State Organic Certifiers* (www.baystateorganic.org). Every certifier must work under standardized USDA rules and all inputs must be listed with OMRI (Organic Materials Review Institute, www.omri.org). This list can be found on the web www.omri.org and a hard copy is supplied with certification. Some products are listed as A (allowed) others as R (restricted). The restricted products have certain conditions attached to them that have to do with the generic materials in the product (amounts or frequency of application, etc.). OMRI also has a Generic Materials List. Three years of no synthetic chemical applications are necessary before a crop can be certified organic (transition period).

Use of cultural practices (sanding and water floods) is the most effective strategy in organic management.

Late Water -- Holding late water is an excellent choice to greatly reduce cranberry fruitworm pressure; however, moths may move into late water-treated beds from other areas of infestation. False armyworm, blossomworm, gypsy moth, and southern red mite may be managed with late water. See Late Water Section.

Fall Flood -- May be used to reduce cranberry girdler populations. Flood for 10-14 days as soon as possible after harvest. May also impact vines to some degree. Warmer water temperatures enhance effectiveness.

Sanding -- If you can sand, populations of most insects should be less abundant.

Winter Flood -- If you can maintain a good winter flood, populations of most insects should be less abundant.

These are options cleared for organic management on cranberry, but efficacy has not been quantitatively assessed.

Azadirachtin products

Aza-Direct	1-3.5 pt	Target small caterpillars with this biological insecticide – it serves as a repellent, antifeedant, and interferes with the molting process. Restricted.
Neemix 4.5	4-16 fl oz	

Bacillus thuringiensis (B.t.) products

Dipel DF (<i>kurstaki</i> strain)	0.5-1 lb	These compounds are most effective when applied multiple times in low gallonage against small caterpillars feeding on foliage. Treating early infestations is critical. Well-timed chemigation systems are critical for good efficacy (6 minutes or less rinse time). Beware, not all B.t.'s are certified organically or have cranberry on the label.
Biobit HP (<i>kurstaki</i> strain)	0.5-1 lb	
Xentari (<i>aizawai</i> strain)	0.5-1.5 lb	

M-pede Insecticidal Soap 1-2% solution No chemigation allowed.

Neem Oil Products

Trilogy	Useful as a dormant application for suppression of southern red mite egg hatch. Do not chemigate. Use 1% rate for ground application or 1 qt/A for aerial application in 10 gallons of water. Be aware that it accelerates plant growth stage and adjust frost protection accordingly. Also suppresses eggs and motile mites post bloom.
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Nematodes Availability limited. Expensive but available organic option for grub and girdler management.

Pyganic EC 1.4	16-64 fl oz	Restricted. Spot treating using low gallonage may be helpful for patchy infestations. Note: other Pyrethrins with added piperonyl butoxide are not allowed.
Pyganic EC 5.0	4.5-18 fl oz	

Entrust 80W 1.25-3 oz This compound is an effective, fast-acting, but short-lived spinosyn insecticide. Do not exceed 9 oz/season. More effective than Bt once caterpillars have reached a larger size. When chemigating, a short rinse time (6 minutes or less) is necessary for good efficacy. Only use lowered rates if chemigation system is 4 minutes or less. Spinosyn compounds are highly toxic to bees, but thoroughly dried residues are safe. Thus sprays must go on at night and dry by morning. Apply when drying conditions are optimal overnight.

WEED MANAGEMENT 2012

Prepared by Hilary A. Sandler

NEW HERBICIDES AND UPDATES. Check our web site and upcoming newsletters for further information about any new uses or products. The manufacturer of Devrinol 10G has discontinued production of this formulation. It is still legal to use Devrinol 10G, so please check with local ag suppliers for availability. Cranberries have been removed from the Princep label; recommendations for its use have been deleted. The tolerance is still in place, so use remaining stock now.

WEED LIFE CYCLES. *ANNUAL PLANTS* complete their life cycle in one year and reproduce by seed (e.g., dodder). *PERENNIAL PLANTS* can live for many years and may reproduce by seed, runners, rhizomes, etc. Most of the weeds in cranberry production are perennials. With the exception of dodder, annual weeds are much less common and easier to control than perennials. However, infestations of annual weeds should not be taken lightly, especially on new plantings. Annual plants are designated with an (A). Unless otherwise noted, all other weeds are perennials.

WEED MAPPING. Weed maps can help you organize the management of your weed problems, especially with perennial weeds. Weed maps should be done every few years, depending on weed pressure and management objectives. Several steps are involved: 1) Correctly identify the weeds, 2) Document the location of the weeds (by drawings or photographs), and 3) Designate a priority number to the weed. Weeds are grouped into priorities (1=no tolerance; 2=serious concern; 3=less concern; and 4=lowest concern) based on their likelihood to cause yield loss, ability to spread, and the difficulty of control. Deal with the most yield-threatening weeds first. Recommended priority groupings are noted in the right-hand margin for each weed. Growers may change and adapt weeds into priority groups to best fit their own management program.

CLIPPER APPLICATORS. Roundup products are the only products currently labeled for use in clipper application (Section 2ee-'Cut Stump'). No other glyphosate products may be used in clipper applicators. Using the correct technique is critical for maximizing the performance of this herbicide application. Roundup must be applied to the stem as it is cut! Good stem coverage and adequate flow without dripping on the vines is essential. Concentrated solutions (50-100% Roundup) work best. Notations are made within each weed management description below if field studies have demonstrated clippers to be effective in giving partial or good weed control.

TIMING OF PREEMERGENCE HERBICIDES. Spring applications are typically done from March through mid-April. Fall applications are typically done 1-2 weeks after harvest but at least 2-3 weeks prior to the winter flood. See the dodder section for specifics of using PRE herbicides for dodder control.

FLAME CULTIVATION (FC) or THERMAL WEEDING. We have preliminary evidence that the use of hand-held propane torches can provide control of some weeds (e.g., dewberry, rushes, and dodder). Applications (in test studies) have been made in the summer months. FC is a good option on organic farms or as an option to continual POST herbicide use. Several torches (open flame, OF or infrared, IR) are available. Cranberry vines can be injured during a FC application but the vines will recover. Short exposures (~5 sec) provide control when using OF; longer exposures are needed (~15-30 sec) with IR.

DODDER (A) *Cuscuta gronovii*

PRIORITY 1

Biology and Control. Dodder is an abundant seed producer. All management efforts should be directed towards minimizing or eliminating seed production. A single plant can produce 1,000's of seeds in one season. The seed bank is very long-lived (>13 yr), so do everything possible to eliminate seed production and/or reduce seed viability.

Dodder is an obligate parasite and must have a host plant to survive. Woody cranberry stems are somewhat less appealing to dodder, so control of succulent weeds (such as goldenrod, loosestrife and

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asters) early in the season may be important. Seedlings continue to emerge over a period of 2 to 3 months, so postemergence controls are usually needed in addition to preemergence herbicides. Where dodder infestations are just beginning, careful scouting and hand removal of seedlings prior to infection is a good practice. Weeds that are infected with dodder should be completely removed from the bed; dodder stems will re-grow if haustoria (the part of the parasite that penetrates the host) remain embedded in the weed. Infected cranberry vine tips can be cut off and thrown away.

Prevention. The best management strategy for dodder control is prevention of infestation. This is best accomplished through good sanitation. Dodder seed is easily moved in harvest water and on equipment. When possible, dodder-infested beds should be harvested after clean beds. Floats used to corral berries should be inspected for the presence of dodder seed before they are placed in beds that are dodder-free. This is especially important for custom harvest operations. A good trash flow after harvest is also helpful in removing seed capsules from the bed, but is not a replacement for prevention since subsequent infestation occurs. Sometimes, growers could consider multiple trash flows if seed production is high.

Dodder may also be spread vegetatively; pieces of stem can be moved on equipment and become attached to healthy plants. Care should be taken when moving any piece of equipment from a bed infested with dodder to one that is not. Equipment should be sanitized in these situations!

Scouting. Scout in areas where infestation has occurred in the past and in bare areas in beds infested previously with dodder. Often, dodder seed will accumulate in the areas where berries are removed from the beds at harvest. Dodder seedlings may also be seen in warm, bare areas or newly sanded areas. Newly emerged seedlings are usually yellow in color, very slender, and 0.5 to 3 inches long. If the vine cover is good, move the vines aside so that you can see the duff layer; this is where early emerging seedlings will be seen.

Begin scouting for dodder in early-mid April (unless your bog history or unusual weather conditions indicates otherwise). Mild winter temperatures may promote earlier emergence of dodder. Recent research indicates that dodder populations in MA emerge slowly at first, but then quickly peak and subside. In these studies, 50% and 90% of the seedlings emerged from about 30 and 45 days after first emergence, respectively. In addition, as the seeds accumulate year after year in the soil, seedlings emerge later and later, creating overlapping generations. The most vigorous population is the one most recently seeded (from last year). It is not known how variable dodder populations are from bog to bog but variation from farm to farm is likely. Growers should consider previous successful experiences, along with scouting, and plan applications of preemergence herbicides accordingly.

Preemergence Herbicide Use. To minimize the loss of Casoron due to volatilization, apply when air temperatures are below 60°F. Apply water immediately to incorporate the herbicide into the soil and to limit volatilization loss. If frequent frost events and/or spring rains occur after application, the water may move herbicide below the dodder seed zone and reduce the effectiveness of the herbicide. Application of Casoron to vines that are stressed for other reasons may cause yellow vine syndrome symptoms or other injury. Vine injury is likely with mid to higher rates if the buds have begun growth.

We do not know if Callisto will control dodder populations when applied preemergence, though some growers have experimented with this application timing. Please contact Hilary at (508) 295-2212 x21, and let her know your observations.

Postemergence Control. For light to moderate dodder infestations, raking is not recommended. Yield and quality are reduced and dodder growth is unaffected. For heavy infestations, raking can prevent the onset of upright dieback caused by infection. It can also prevent leaf-drop due to shading of the cranberry by the dodder canopy. Raking prior to seed set is not as effective in reducing dodder seed production as raking after seed set. Raking should be done before the seed capsules begin to dry. No benefit is provided from raking earlier as the dodder stems re-grow from the portions embedded within the cranberry. No benefit is gained from raking more than once.

Trash flows after harvest are also helpful in removing seed pods (capsules) from the bog.

POST applications of Callisto seem to control dodder, especially if the host is a weed that Callisto can damage. Callisto is not effective when dodder is attached to cranberry. Dodder will turn white after application, and may re-grow. Applications made before dodder flowers seem more effective than those made after flowering; higher rates are better. There is evidence that thermal weeding may control dodder with minimal injury to cranberry. Call the Weed Specialist if you want to try this control option.

Resistance Management Concerns. Resistance to Callisto has been reported in other crops after only 7 years of use. It is important that we do not lose this tool for dodder management. Consider rotating Casoron and Callisto for dodder management and use cultural methods of control. Do not use Callisto repeatedly year after year.

CHEMICAL RECOMMENDATIONS FOR DODDER CONTROL

Preemergence

Casoron 4G 30-60 lb/A Apply within 10-14 days of early seedling emergence. Follow with 0.2" water to incorporate herbicide. Split applications can be used (up to a total of 100 lb/A in a 12-month period). Allow at least 3 weeks between applications. See Notes on Casoron.

Postemergence

Callisto 4-8 oz/A Two applications (separated by at least 14 days) of Callisto are permitted each growing season (not to exceed 16 oz/A total). As a spot application, use in 20-30 gal water. Mix 0.8 teaspoon in 1 gal water for 4 oz/30 gal water rate. Add a nonionic surfactant (NIS) at 0.25% v:v or 1.9 tsp per gallon or crop oil concentrate (COC) at 1% v:v or 2.5 Tbsp per gallon with all postemergence applications, regardless of Callisto rate. If chemigating, see Notes on Callisto at end of this section. **See Resistance Management Concerns above.**

Spring Floods. Recent research and grower experience has shown that short (24-48 hr) floods in early to mid-May may be effective for reducing dodder infestations. Research is on-going to determine the best timing for maximum efficacy. Floods should cover vine tips adequately. No adverse vine or yield impact has been reported when growers have held these spring floods. Dodder floods may coincide with floods used to control black-headed fireworm. Flooding dodder 3-4 weeks after early seedling emergence appears to be more effective (compared with flooding 1-2 weeks after early seedling emergence).

BRISTLY & PRICKLY DEWBERRY *Rubus hispidus*, *R. flagellaris* (Running brambles) PRIORITY 1

Dewberries spread rapidly on bogs by rooting at the tips of canes. Both types will kill vines if allowed to spread. The most effective way to manage dewberries is to eliminate them as they invade the bog. Remove young plants by pulling or digging out by the roots. Control of established plants with glyphosate products is difficult because the weed grows close to vine level. Sparse or moderately colonized spots can be hand wiped with glyphosate products. Clipping stems with Roundup-dispensing applicators may offer partial control.

NON-CHEMICAL OPTIONS

Late water floods reduce numbers of dewberry crowns and offspring plants in that year. Summer refloods (May 10-12 through July 15-20) may be used in desperate circumstances. This will eliminate the crop for that year! It is particularly helpful to hand pull or hand wipe remaining dewberry plants after the flood has been withdrawn. Fall floods may suppress populations of *R. hispidus*; results have varied from no impact to reduced crown density. Start the flood as early as possible (mid-September) and hold for 4 weeks for best dewberry management. Consider starting a fall flood in early-mid September, if possible. It is important to remove the flood by early November to allow the vines time to become dormant prior to winter.

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Recent research indicates that using flame cultivation (FC) or thermal weeding (hand-held flame cultivators or torches) reduce dewberry growth when compared to untreated plants. One short duration (3-6 sec/yd² if using an open flame torch; longer times, 15-30 sec are needed with infrared torches) exposure made mid-summer seems effective (reduces shoot and root biomass). Cranberry vines will be injured when exposed to thermal weeding but they will recover. Typically, however, few cranberry vines are present in heavy dewberry infestations, so the risks are much lower than in well-vined areas. Contact the IPM Lab (x21 or x27) if you have interest or questions about thermal weeding.

Knife-raking or pruning in the fall may help uproot offspring plants. Significant dewberry patches should be scraped and replanted with new vines.

DEWBERRIES - CHEMICAL RECOMMENDATIONS

Roundup WeatherMAX	Mix 1 part glyphosate with 4-9 parts water (10-20% solutions). No additional additives, buffers, or surfactants are needed. However, the addition of ammonium sulfate may sometimes improve performance.
+ A marker dye (e.g., Blazon Blue)	Add according to manufacturer's recommendations.
Glyphosate products	Mix 1 part glyphosate with 4-9 parts water (10-20% solutions).
+ Surfactant	1 oz (2 tablespoons) per gallon of glyphosate mixture.
+ Ammonium sulfate	3 oz (6 tablespoons) per gallon of glyphosate mixture.
+ A marker dye (e.g., Blazon Blue)	Add according to manufacturer's recommendations.
Weedar 64	Mix 1 part Weedar to 2 parts water for hockey stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.
Callisto	Two applications (separated by at least 14 days) of Callisto are permitted each growing season (not to exceed 16 oz/A total). As a spot application, use in 20-30 gal water. Mix 0.8 teaspoon in 1 gal water for 4 oz/30 gal water rate. Add nonionic surfactant (0.25% v:v or 1.9 tsp per gallon) or COC (1% v:v or 2.5 Tbsp per gallon) with all postemergence applications, regardless of Callisto rate. If chemigating, see Notes on Callisto at end.

Callisto will discolor and injure dewberries, however, the long-term management of this weed with Callisto is not yet known. Use 2 applications of Callisto (at least 14 days between applications) to manage dewberry infestations. Repeated annual applications will likely be necessary to reduce infestations. If dewberries are in a mixed canopy with tall weeds, target the spray to reach the lower portion of the canopy (where the dewberries are).

GLAUCOUS GREENBRIER *Smilax glauca* (Silverleaf sawbrier)

PRIORITY 1

Greenbriers are very difficult to control because they have extensive underground storage organs. Glaucous greenbrier (silverleaf) is more difficult to control than common greenbrier (greenleaf). Glaucous grows in dense patches, spreads rapidly, and usually reaches just above vine level. It significantly impacts fruit production. Digging up the root system is not practical and will cause significant vine and bog damage. Infestations of sawbrier are more likely to occur on high edges or in locations where the bed is out of grade.

S. glauca may be managed by hand wiping if sufficient coverage is obtained. Summertime wipes of Roundup may offer partial control. Clipping stems with Roundup-dispensing applicators in August may offer an additional partial control. Severe infestations of *S. glauca* may necessitate bog renovation. Weedar 64 and Callisto may be used on sawbrier as per dewberry recommendations. Flooding is not

effective against sawbrier. Recent research indicates that one exposure of a mid-summer thermal weeding (hand-held flame cultivators or torches) treatment may not be effective for reducing sawbrier growth.

POISON IVY *Toxicodendron radicans*

PRIORITY 1

Poison ivy is getting worse on many bogs. Treat small infestations early and eradicate! Control is very difficult because the weed grows close to the vines. Glyphosate wipes will control this weed, but the potential for vine damage is high. Use of specialized applicators that minimize drip is recommended. Research has shown that clipping the stems with Roundup-dispensing applicators may offer partial control. Early-mid September applications may give better control than August applications. Again, late applications can be used on bogs that will not be harvested due to crop-destruct floods (or very late harvested bogs). Rates as low as 5-10% solutions gave decent control. Control for significant infestations of poison ivy is post-harvest spot treatments with Roundup sprays or mechanical spot renovation followed by replanting. Adding 1 part Weedar 64 to 4 parts of the Roundup mixture may be helpful but will likely increase the possibility of crop injury. See 2,4-D cautions.

Reports of control with Callisto are variable; some growers have had good luck and others reported no control. If using this herbicide, make 2 applications of Callisto against this tough weed (see dewberry recommendations). Earlier applications (May) seem better than later applications (July). Tank mixes of Poast and Callisto have been reported to control PI patches (repeated annual applications usually needed). Call extension specialist for rates. Consider resistance management concerns when using Callisto.

DO NOT USE thermal weeding or burning for poison ivy control. The toxic plant components can become air-borne and cause significant health problems.

Many people are highly allergic to poison ivy. Protective lotions and soaps are available that minimize the irritation caused by the poison ivy oils; these work very well when applied according to label instructions. Lotions are usually applied prior to exposure and soaps are used to remove oils after exposure to the plant. Rinse with a lot of cool water; small amounts of water may only spread the oils.

YELLOW LOOSESTRIFE *Lysimachia terrestris*

PRIORITY 2

Yellow loosestrife can cause moderate yield reductions. It may also serve as an early-season host for dodder and tips may harbor *Sparganothis* larvae. Loosestrife may be wiped with glyphosate during the season. Fall applications of Casoron may also offer some control of loosestrife. Since loosestrife is difficult to control, efforts should begin while patches are still small and before they have a chance to spread. Efficacy of Callisto on yellow loosestrife seems low and/or variable.

Biological Control? We have good evidence that there is a fungus that is killing YLS plants. If you notice dying plants on your farm, please contact Hilary (x21) or Frank (x18) so we can collect samples.

CHEMICAL RECOMMENDATIONS

Casoron 4G	up to 100 lb/A	Spring or fall application. Offers partial control. See Notes on Casoron.
Roundup WeatherMAX	Apply anytime weeds are present except 30 days before harvest.	
Glyphosate products	See Notes on Roundup.	
Weedar 64	Mix 1 part Weedar to two parts water for hockey-stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.	

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WILD BEAN *Apios americana* (Ground Nut)

PRIORITY 2

Wild bean can be well controlled with Stinger applications. Repeated annual applications may be needed for large or severe infestations. Nuts may be dug out and removed from the bog. When using wipes, stake the wild bean vines to make wiping easier. Some growers have reported good wild bean control with Callisto; Stinger provides superior control but carries a greater risk of vine injury.

WILD BEAN - CHEMICAL RECOMMENDATIONS

Preemergence Options

Casoron 4G 75 lb/A

FOLLOWED BY

Devrinol 50DF 15 lb/A or

Devrinol 10G 75 lb/A

Apply as two separate applications. Time applications before rain or irrigate within one day. Apply late March to early April. For best results, allow 10 days between applications.

Postemergence Options

Stinger *Spray:*
0.06-0.12 oz/gal

0.37-0.75 tsp (1.8-3.6 ml) per gallon. Wild bean is very sensitive to Stinger (rates are lower than usual label rates).

Wipe: 2.5 oz/gal

5 Tbsp per gallon (2% solution). See Notes on Stinger.

Salt 1 lb/gal water

Apply during the summer months after berry set. Never spray more than 200 gal/A. This practice keeps bean tops burned off. Repeat as necessary. Wash equipment with soap and water immediately after use.

Glyphosate products

Apply anytime weeds are present except 30 days before harvest.

Roundup WeatherMAX

For rates, see below and Notes on Roundup.

ASTERS *Aster spp.*

PRIORITY 2

The impact of asters on cranberries is variable. Asters are usually found in bare patches on the bog. Once the patch becomes established, asters are much harder to control. Applications of Casoron in March-April or November offer some suppression but will probably not eradicate this weed. Higher rates of Stinger offer the best option; apply to minimize any vine injury. Glyphosate wipes in the summer may be helpful. Thorough coverage and repeat applications are necessary. Some growers report efficacy with Callisto against asters, but results were not always compelling.

CHEMICAL RECOMMENDATIONS FOR ASTERS

Preemergence Options

Casoron 4G up to 100 lb/A

Apply Spring or Fall. See Notes on Casoron.

Postemergence Options

Iron sulfate 3 oz/sq. ft

Apply during Summer. See Notes on Iron Sulfate.

Weedar 64

Mix 1 part Weedar to two parts water for hockey stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.

Stinger *Spray:* 0.33-0.5 oz/gal
Wipe: 2.5 oz/gal

2-3 tsp (9.8-14.8 ml) per gallon. See Notes on Stinger.
wipe: 5 Tbsp per gallon (2% solution).

NARROW-LEAVED GOLDENROD *Euthamia tenuifolia***PRIORITY 2**

Narrow-leaved goldenrod causes little direct yield loss, but is extremely difficult to control and spreads rapidly. For this reason, every effort should be made to control patches before they spread. Preemergence and postemergence herbicides can provide partial control of this weed. Clipping the stems with Roundup-dispensing applicators in August may offer partial control.

Stinger applications should also offer reasonable control of NLGR. Use the lowest effective rate of Stinger as cranberry vine injury is likely with over-application or off-target coverage. Data indicate that Callisto works very well against NLGR.

CHEMICAL RECOMMENDATIONS**Roundup WeatherMAX /
Glyphosate products**

Apply anytime weeds are present except 30 days before harvest. See Notes on Roundup.

Weedar 64

Mix 1 part Weedar to two parts water for hockey stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.

Stinger

Spray: 0.33-0.5 oz/gal

2-3 tsp (9.8-14.8 ml) per gallon. See Notes on Stinger.

Wipe: 2.5 oz/gal

wipe: 5 Tbsp per gallon (2% solution).

Callisto

Two applications (separated by at least 14 days) of Callisto are permitted each growing season (not to exceed 16 oz/A total). As a spot application, use in 20-30 gal water. Mix 0.8 teaspoon in 1 gal water for 4 oz/30 gal water rate. Add nonionic surfactant (0.25% v:v or 1.9 tsp per gallon) or COC (1% v:v or 2.5 Tbsp per gallon) with all postemergence applications, regardless of Callisto rate. **If chemigating, see Notes on Callisto at end.**

CINQUEFOIL *Potentilla canadensis, P. simplex* (Five-finger)**PRIORITY 2**

The impact of cinquefoil is variable, but infestations seem to be getting worse, thus its classification as a Priority 2 weed. Colonization of cinquefoil may indicate a problem with vine growth and high pH (too basic, alkaline). Improvement of fertilizer program may help control this weed. Callisto seems to work well on this weed, but it takes a while for symptoms to appear and for the weed to die; be patient! Hand wiping or hand pulling can also be used to eliminate small patches. If the soil is considered alkaline, the use of sulfur may help improve the soil condition such that the cranberry vines become more competitive. See Notes on Sulfur. Growers report using 60 lb Casoron in early May (as a spot-treatment) with very good results.

CHEMICAL RECOMMENDATIONS FOR CINQUEFOIL**Callisto**

Two applications (separated by at least 14 days) of Callisto are permitted each growing season (not to exceed 16 oz/A total). As a spot application, use in 20-30 gal water. Mix 0.8 teaspoon in 1 gal water for 4 oz/30 gal water rate. Add nonionic surfactant (0.25% v:v or 1.9 tsp per gallon) or COC (1% v:v or 2.5 Tbsp per gallon) with all postemergence applications, regardless of Callisto rate. **If chemigating, see Notes on Callisto at end.**

Iron sulfate 20% 3 oz/sq. ft

Apply during the summer months. Several formulations and percent active ingredient of iron sulfate are available. Granular forms are easier to apply (drop-spreader), but take longer to act than finely powdered formulations. See Notes on Iron sulfate.

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COMMON GREENBRIER *Smilax rotundifolia* (Greenleaf sawbrier, bullbrier)

PRIORITY 2

Common greenbrier is bushier and spreads more slowly than glaucous greenbrier and grows well above the cranberry vines. It is easier to control with glyphosate wipes than glaucous greenbrier. Thorough coverage is important. Repeat applications in successive years may be needed for total control. See Notes on Roundup. Digging up the root system is not practical and will cause significant vine and bog damage.

SEDGES

PRIORITY 3

Management of sedges combines cultural and chemical controls. Hand dig, pull small patches or spot-treat with one of the preemergence herbicides listed below. Encourage vine growth in the bare areas so the sedges will not re-colonize. Refer to the table below to locate the target weed and recommended control options and related information. **TIMING:** Spring applications are typically done from March through mid-April; Fall applications are typically done 1-2 weeks after harvest but at least 2-3 weeks prior to the winter flood. (S) or (F) following the weed name indicates 'Spring only' or 'Fall only' applications are preferred.

SEDGES - CHEMICAL RECOMMENDATIONS			
HERBICIDE	RATE	WEEDS CONTROLLED	NOTES
<u>Preemergence Options</u>			
Devrinol 50DF	12-18 lb/A 8-12 lb/A	Nut sedge (nutgrass)	Rate for peat-based bogs. Rate for mineral soils.
Devrinol 10G	60-90 lb/A (peat) 40-60 lb/A (mineral)		Works best when applied to a weed free surface.
Casoron 4G	up to 100 lb/A	Cottongrass, Dulichium (S), Fresh meadowgrass (F), Needlegrass, Nut sedge, Spike rush, Woolgrass	
Evital 5G	80-120 lb/A 120-160 lb/A	Needlegrass (S), Nut sedge Broomsedge, Needlegrass (F), Spike rush, Woolgrass	Needlegrass is difficult to hand pull. Broomsedge may be controlled with glyphosate wipes. Dig up clumps.
<u>Postemergence Options</u>			
Callisto	4-8 oz/A	Nut sedge, perhaps others	See use on 'Cinquefoil' above. If chemigating, see Notes on Callisto at end.
Weedar 64		Three-square	Mix 1 part Weedar to two parts water for hockey stick application. Best results when used in late June and July. Do not drip or touch vines.

CHOKEBERRY *Pyrus melanocarpa*

PRIORITY 3

Infestations of chokeberry can reduce yields and will spread in the beds. The best management strategy is to treat patches before they get too large. Chokeberry plants do not grow tall on the bog. Take extra care when using postemergence wipes of glyphosate products to minimize vine injury. When chokeberry plants are short, it may be more effective to hand wipe them rather than wiping with a hockey stick wiper.

SHEEP LAUREL *Kalmia angustifolia*

PRIORITY 3

Sheep laurel can spread on the bog and reduce yields. Saplings should be pulled by hand. Larger plants can be wiped with glyphosate products (see Notes on Roundup).

LEATHERLEAF *Chamaedaphne calyculata***PRIORITY 3**

Leatherleaf is a perennial, woody plant that can spread on the bog and reduce yield. It can be controlled by hand wiping during the summer with a solution of glyphosate products. Weedar 64 can also be used as a wipe as per dewberry recommendations.

RUSHES *Juncus* spp.**PRIORITY 3**

Rushes grow in clumps and can become quite large when well established. Control of large plants with preemergence herbicides may be difficult except at very high rates. Control may also be possible with hand-digging or repeated hand wiping with glyphosate solutions. **TIMING:** Spring applications are typically done from March through mid-April. (S) following the weed name indicates if 'Spring only' applications are preferred. Use glyphosate wipes in summer. We have preliminary evidence that flame cultivation (thermal weeding) may help to control rushes. Call Hilary at ext. 21 if interested.

RUSHES - CHEMICAL RECOMMENDATIONS

HERBICIDE	RATE	WEEDS CONTROLLED	NOTES
<u>Preemergence Options</u>			
Devrinol 50DF	12-18 lb/A 8-12 lb/A	Soft rush (<i>J. effusus</i>)	Rate for peat-based bogs. Rate for mineral bogs.
Devrinol 10G	60-90 lb/A (peat) 40-60 lb/A (mineral)		Works best when applied to a weed free surface.
Casoron 4G	up to 100 lb/A	Canada (S), Mud, Soft (S)	Offers partial control for Canada rush.
Evital 5G	120-160 lb/A	Canada rush	
Salt	1-3 teaspoons		Apply sodium salt to the base of each rush clump in the spring, prior to bud break.

RED MAPLE and other trees**PRIORITY 3**

The best management strategy is to pull saplings before the root system becomes established (hopefully less than 1 year old). Larger trees must be dug out. Glyphosate wipes may be used to control small maples and to weaken large trees to facilitate removal. Clipping stems with Roundup-dispensing applicators in August may offer partial control. WI reports best results with early applications of Callisto at high rates with COC.

CHEMICAL RECOMMENDATIONS

Roundup WeatherMAX / Glyphosate products	Apply anytime weeds are present except 30 days before harvest. Good coverage is essential. See Notes on Roundup.
Weedar 64	Mix 1 part Weedar to two parts water for hockey stick application. Best results are obtained when used in late June and July. Do not drip or touch vines. Labeled for red maple only.
Callisto	See recommended use patterns above. If chemigating, see Notes on Callisto at end.

UPRIGHT BRAMBLE *Rubus allegheniensis* (Blackberry)**PRIORITY 3**

Upright bramble is not as common as the dewberries. It does not trail on the ground. Control may be obtained with glyphosate wipes. Young plants can be pulled or dug out by the roots. Weedar 64 may be used as described for other *Rubus* (dewberries) species. This weed is not common on cranberry farms.

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PERENNIAL GRASSES

PRIORITY 3

These grasses often colonize bare areas. Encouraging vine growth may reduce potential for problems. Some species may be difficult to eradicate once established. Postemergence herbicides are now available for grass control on bearing and non-bearing beds. **TIMING:** Spring applications are typically done from March through mid-April; Fall applications are typically done 1-2 weeks after harvest but at least 2-3 weeks prior to the winter flood.

Do you have Poverty Grass? Growers are reporting that poverty grass is becoming more of a problem on many bogs. It is not known if the weed is the grass known as little bluestem (*Schizachyrium scoparium*) or another grass species that is just referred to as poverty grass. If you suspect you have poverty grass, please contact Hilary (x21) so specimens can be collected and identified.

PREEMERGENCE OPTIONS

<i>Broad-leaved panicgrass</i>	Evital. Gives partial control.
<i>Mannagrass</i>	Use Casoron (Spring).
<i>Poverty grass</i>	Devrinol applications combined with repeated mowing to remove seed heads is the best recommendation we have at this point.
<i>Rattlesnake grass</i> <i>Rice cutgrass</i>	Casoron (Spring). Clean ditches in infested area. Pulling helps a little. Best choice is Devrinol applied before April 10. Casoron and Evital can also be used; give partial control. Improve drainage. Can tolerate pH<3.
<i>Smokegrass</i> <i>Summergrass</i> <i>Switchgrass</i>	Evital (Spring). Devrinol, Casoron or Evital. Hard to mow. Evital (Fall). Difficult to control, repeated mowing helps. Best to dig out plants prior to seed formation.
<i>Velvetgrass</i>	Casoron

PRE HERBICIDE RATES:

Devrinol 50DF	12-18 lb/A	for peat-based beds
	8-12 lb/A	for mineral soils
Casoron	up to 100 lb/A	
Evital	80-120 lb/A	Spring
	120-160 lb/A	Fall

POSTEMERGENCE OPTIONS

Poast and Select only work on Grasses! Contact Weed Specialist for ID if needed.

Poast	Use 1-1.5% solution. Mix 2 oz Poast + 0.6 oz Dash HC or 1.3 oz crop oil concentrate per gallon (for 1.5%). Repeat applications may be needed. Addition of other adjuvants is not recommended. May be applied by broadcast applicator or air. Chemigation not permitted! See Notes on Poast.
Select MAX	Chemigation not permitted. 9-16 oz/A per application. Add 0.25% v/v non-ionic surfactant (NIS) unless label indicates otherwise. Repeat applications may be needed. Use 10-30 gal water per acre. For each gal, mix 1.3 Tbsp (0.65 oz; 19 ml) + 0.65 Tbsp (0.33 oz; 10 ml) NIS for a mid-range rate. Allow 14 days btw applications. Do not apply between hook and full fruit set.
Callisto	Efficacy may be variable. See use pattern recommendations above. If chemigating, see Notes on Callisto at end.

PHRAGMITES *Phragmites australis* (Common reed)**PRIORITY 3**

This highly invasive species and aggressive weed has been recently sited on a few commercial bogs. It should be treated and controlled immediately!! The best treatment is glyphosate applications in early to mid-summer (before it gets too tall) followed by mowing approximately 4-8 weeks after herbicide application. Control any infestations that are occurring near the bog as well.

PINEWEED *Hypericum gentianoides***PRIORITY 3**

Pineweed is becoming more problematic on bogs, especially new plantings. Sometime, other common names are used for this plant (horsetail, horseweed, or mare's tail), but these are very different plants. This plant may also be known as orangegrass, but we are not encouraging use of this name since this plant is a broadleaf and not a grass. High rates of Casoron should control pineweed but be careful using Casoron on new plantings. In WI, growers reported good control with 30 lb/A Casoron. Some growers are trying fall applications (postharvest) of Poast, but efficacy is not yet verified. There has been a report of efficacy with preemergence applications of Callisto, but this has also NOT been verified. Pineweed can be hand-pulled if infestations are not too large.

MOSSES *Polytrichum spp.* (Haircap moss), *Sphagnum spp.* (Sphagnum moss)**PRIORITY 4**

The presence of these plants on the bog may indicate a drainage problem. Evaluate the drainage in the area and improve prior to starting a chemical control plan. Applications of acetic acid made in mid-summer have shown good control of haircap moss. A 20% acetic acid product by Weed Works, Inc., sold as a horticultural biopesticide, received labeling in Fall 2010 for use on food crops. Our lab has no experience with this product. Our experience with acetic acid has indicated that multiple (at least 2) applications may be necessary and that rather weak solutions can still be effective (e.g., 20-40% solutions of 5% acetic acid).

HAIRCAP MOSS - CHEMICAL RECOMMENDATIONS

Casoron 4G	up to 100 lb/A	See Notes on Casoron. Be judicious in applying high rates for moss control, especially on vines showing signs of stress.
Ammonium sulfate	15 oz/100 sq. ft	21-0-0. Apply in the Spring.

SPHAGNUM MOSS - CHEMICAL RECOMMENDATIONS

Iron sulfate	3 oz/sq. ft	Apply in March to mid-April. See Notes on Iron Sulfate.
Casoron 4G	up to 100 lb/A	Apply in the Fall only. See Notes on Casoron.

WHITE VIOLET *Viola lanceolata***PRIORITY 4**

Found most often in bare patches on beds, white violet is thought to compete poorly with established vines. Thus, the best management approach is to fill in bare spots on the bog by encouraging runner growth. Otherwise, hand pulling is the next best recommendation, especially on new bogs. No chemical controls are recommended.

Callisto can also control clover (see use pattern recommendations above). However, vine overgrowth has been reported in heavily infested (treated) areas after clover dies back (apparently acts like a green manure, releasing nitrogen into the soil).

JOE-PYE WEED *Eupatorium dubium***PRIORITY 4**

This perennial plant generally grows along the ditch areas. Due to its tough stem, it may be difficult to hand-weed. Some growers use pliers to uproot large plants. Glyphosate wipes during the summer offer good control. Stinger should also control this weed.

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PITCHFORK, RAGWEED, AND FIREWEED (A)

PRIORITY 4

Bidens frondosa, *Ambrosia artemisiifolia*, and *Erechtites hieracifolia* (Beggarstick, stick-tights, Spanish needles/Common ragweed, hogweed, bitterweed, Roman wormwood/Cottonweed, pilewort.)

PITCHFORK, RAGWEED, & FIREWEED – CHEMICAL RECOMMENDATIONS

Preemergence Options

Casoron 4G	up to 100 lb/A	Apply in Spring. May also be applied in the Fall for control of ragweed. Moderate rates are suggested.
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Postemergence Options

Weedar 64	for ragweed only	Mix 1 part Weedar to two parts water for hockey stick application. Best results are obtained when used in late June and July. Do not drip or touch vines.
Stinger	<i>Spray:</i> 0.33-0.5 oz/gal	2-3 tsp (9.8-14.8 ml) per gallon. Pitchfork and ragweed are sensitive to Stinger, so use lowest effective rate. 1/16 oz/A rate= 0.04 tsp or 1.8 ml per gallon.
	<i>Wipe:</i> 2.5 oz/gal	wipe: 5 Tbsp / gal (2% solution). See Notes on Stinger.

JAPANESE KNOTWEED *Polygonum cuspidatum* (Mexican bamboo, Fleeceflower)

PRIORITY 4

This is an invasive species that has been seen on bog ditches and rarely on the bog itself. It is common (relatively) on new plantings. JK has heart-shaped leaves that become quite square at the end close to the stem. It produces abundant white flowers in June-July. It is a perennial plant and can form dense patches (large rhizome system underground). It may die back at the end of the season and form a dense mat of dead material. The best control is prevention!! Cutting, mowing and flame cultivation should also provide control of established plants, but it is absolutely best to eradicate before the plant establishes.

MEADOWSWEET *Spiraea latifolia*

PRIORITY 4

Meadowsweet is a slow spreader on cranberry bogs. This weed should be pulled out by hand or wiped during the summer.

CHEMICAL RECOMMENDATIONS

Roundup WeatherMAX	Apply anytime weeds are present except 30 days before harvest.
Glyphosate products	See Notes on Roundup.

CLOVER AND VETCH *Trifolium repens*, and *Vicia* spp.

PRIORITY 4

Clover and vetch tend to occur in areas of very high pH (alkaline soils). If soil pH is 5.0 or above, spot treat with two applications of sulfur at the rate of 0.2 oz/sq. ft. Apply in the late spring when soil is drained and frost protecting is over. For more details, refer to Notes on Sulfur. Lower rates of herbicides may be effective when sulfur has been added and the pH is lowered.

Stinger offers good postemergence control of these weeds (use rates similar to asters and narrow-leaved goldenrod). See 'Stinger notes' at the end of the weed section. Control clover early spring prior to budbreak.

Callisto can also control clover (see use pattern recommendations above). However, vine overgrowth has been reported in heavily infested (treated) areas after clover dies back (apparently acts like a green manure, releasing nitrogen into the soil).

ANNUAL GRASSES**PRIORITY 4**

Generally, annual grasses are most likely to appear in bare patches and/or on new bogs. Hand pulling and/or treatment with postemergence grass herbicides may be used on new and established bogs. Encourage vine growth to reduce ability of weeds to colonize the bog surface. Preventing seed production may also be important in managing these weeds. **TIMING:** Spring applications are typically done from March through mid-April. (S) following the weed name indicates if 'Spring only' applications are preferred.

CHEMICAL RECOMMENDATIONS FOR ANNUAL GRASSES - PREEMERGENCE OPTIONS

HERBICIDE	RATE	WEEDS CONTROLLED	NOTES
Devrinol 50DF	12-18 lb/A 8-12 lb/A		Rate for peat-based bogs. Rate for mineral soils.
		Barnyardgrass, Corn grass, Warty panicgrass (S)	Take action to promote vine growth.
Casoron 4G	up to 100 lb/A	Crabgrass (S)	Take action to promote vine growth.
Evital 5G	120-160 lb/A	Barnyardgrass, Corn grass	Take action to promote vine growth. See Notes on Evital for new plantings.

ANNUAL GRASSES - POSTEMERGENCE OPTIONS

Poast	1-1.5% solution +Dash HC (0.5%) OR crop oil concentrate (1%)	True grasses only!	For each gallon, mix 2 oz Poast plus 0.6 oz. Dash HC or 1.3 oz crop oil concentrate. See Notes on Poast.
Select MAX	9-16 oz/A per application + 0.25% v/v non-ionic surfactant (NIS) in the finished spray volume unless label indicates otherwise. Allow 14 days between applications.		True grasses only. Chemigation not permitted. Repeat applications may be needed. Use 10-30 gal water per acre. For each gal, mix 1.3 Tbsp (0.65 oz; 19 ml) + 0.65 Tbsp (0.33 oz; 10 ml) NIS for a mid-range rate. Do not apply between hook and full fruit set.
Callisto	Efficacy may be variable.		See use pattern recommendations above. If chemigating, see Notes on Callisto at end.

HARDHACK *Spiraea tomentosa* (Steeplebush)**PRIORITY 4**

Hardhack is a solitary plant that does not spread except through seed. Wiping or pulling this weed is very effective, but the roots of hardhack can be woody and larger plants may cause damage to the bog when pulled.

CHEMICAL RECOMMENDATIONS

Roundup WeatherMAX/ Glyphosate products	Apply anytime weeds are present except 30 days before harvest. See Notes on Roundup.
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FEATHER, ROYAL, CINNAMON, AND SENSITIVE FERNS

PRIORITY 4

Dryopteris thelypteris, *Osmunda regalis*, *Osmunda cinnamomea*, *Onoclea sensibilis*

(S) or (Smr) following the weed name indicates if “Spring” or “Summer” applications are preferred. When using iron sulfate treatments, apply a small amount to each plant. See Notes on Casoron and Iron Sulfate.

<u>FERNS - CHEMICAL RECOMMENDATIONS</u>			
<u>HERBICIDE</u>	<u>RATE</u>	<u>WEEDS CONTROLLED</u>	<u>NOTES</u>
<u>Preemergence Options</u>			
Casoron 4G	up to 100 lb/A	Bracken fern (S) Royal fern (S)	Appears on bogs showing signs of stress. Spot-treat and use moderate rates.
<u>Postemergence Options</u>			
Iron sulfate	2 oz/sq. ft [20% a.i.] See Iron Sulfate notes	Feather fern (Smr) Sensitive Fern (Smr)	Sensitive fern is difficult to hand weed due to perennial rhizomes breaking. Use caution on bogs that have been sanded within 18 months.
Iron Sulfate & Salt	9:1 ratio (iron:salt)	Cinnamon fern, Feather fern, Sensitive fern	Treat during the summer months. Place a small amount at the base of each plant.

MINOR WEEDS

PRIORITY 4

[Blue joint (*Calamagrostis canadensis*), Hawkweed (*Hieracium* spp.), Horsetail (*Equisetum* spp.), *Hypericum* spp., Marsh St. John's Wort (*Triadenum* spp.), Sweet pepperbush (*Clethra alnifolia*), Plantain (*Plantago* or *Littorella* spp.), Smartweed (*Polygonum* spp.), Sorrel (*Rumex* spp.), and Wild Strawberry (*Fragaria* spp.)]

If weeds are scattered or of minor importance, consider potential vine stress or injury when choosing herbicide and rate. Consider hand pulling instead. For localized weed patches, consider spot treatment. Postemergence treatment with glyphosate products may also offer some control. Combine herbicide treatments with steps to improve vine growth. Growers have reported good control of horsetail with an herbicide available in 2010 on a Section 18 permit. Check with the Weed Specialist to confirm the use status for 2011.

<u>CHEMICAL RECOMMENDATIONS</u>	
<u>Preemergence Options</u>	
Casoron 4G	Use lowest rates possible. Apply in Spring or Fall. See Notes on Casoron.
<u>Postemergence Options</u>	
Weedar 64	Mix 1 part Weedar to two parts water for hockey stick application. Best results are obtained when used in late June and July. Do not drip or touch vines. Labeled for <i>Hypericum</i> species and sweet pepper bush only.

AQUATIC WEEDS on bog (*Hydrilla*, *Elodea*, *Water lettuce*, etc.) Make sure any aquatic weed control that is performed within the bog system (irrigation laterals, ditches) is done with a product labeled for CROP use. Nautique (by SePro) has crop uses on its label. It is labeled to control floating, emersed, and submersed vegetation in still or flowing aquatic sites such as reservoirs, ponds, slow-flowing water bodies, crop and non-crop irrigation systems. Application rate varies by vegetation density and depth of treated area. Please read the label. If you have any questions, please consult with Weed Extension specialist prior to treating.

ALGAE (*Green scum*) Algaecides are usually prescribed on an acre-foot basis. An acre-foot is the amount of water needed to cover one acre of bog with one foot of water (~300,000 gallons of water, assuming the bog is level). Barley straw can also be used to help control algae. When water temperatures are cool (<50°F), it may take 6-8 weeks for the straw to decompose; 1-2 weeks if water temperature is >68°F. The bales should be contained in nets and maintained at the surface (floats can be inserted) to be most effective. Manufacturers recommend 4 bags (5-7 lb each) per 0.25 acre.

The products listed below are legal for use in cranberry farms. Many other available algaecide products are not for use in food crop systems; check with the Weed Specialist if you have questions about other products.

ALGAE - CHEMICAL RECOMMENDATIONS

Copper sulfate	4 lb/A-ft	Apply evenly on ice or in bog waters. When bogs are treated during winter months, water should be impounded for 5-7 days to allow for degradation in cool-temperature water. May also be used in late water.
Algae-Pro	0.75-1.5 gal/A-ft	Amount will vary depending on product, water volume, and algal density. Carefully read the label before application. See Notes on Copper Sulfate and Copper Complexes.
Cutrine-Plus	0.6-1.2 gal/A-ft	

NON-CROP USE !! OUTSIDE OF BOG AREA – WEED MANAGEMENT

AQUATIC WEEDS. Reports of grower problems with aquatic weeds have been increasing. Aquatic weeds can be submersed, floating plants, floating leaf plants or emergent plants. Common aquatic species for our area may include fanwort, variable watermilfoil, bladderwort, hydrilla (new one to look out for), duckweed, and water lilies. Be sure to get a correct identification of the weed problem before treating. Treatment of some water areas may require a permit. Non-chemical methods (e.g., harvesting, suction, hand pulling, dredging) are available but are very expensive. The use of grass carp for aquatic weed control is NOT permitted per MA Fish and Wildlife. Call 508-389-6300 for more information.

CHEMICAL RECOMMENDATIONS

Diquat	1-2 gal per surface acre	Use during Summer months. Water use is restricted for various time periods depending on product and pattern of use. CHECK THE LABEL! Use only on <u>still water</u> areas outside of bog (e.g., farm ponds, reservoirs). Water temperature should be >50°F for best activity. Do not use in or on bog ditches.
Reward	(37% ai diquat bromide)	
Rodeo	(54% ai) 1.25% solution	Apply during the Summer months. Rodeo is registered for use on noncrop land only. Use in interior ditches is not permissible. Recommended spray solution: 5 oz/3 gallons. <u>Add a nonionic surfactant</u> at the rate of 0.25-0.50% volume basis (1-2 oz or 2-4 Tbsp in 3 gal.).
		More effective against cattails and water lilies. Not effective against submersed weeds.

WOODY AND BROADLEAF PERENNIALS (not in ditches or canal banks)

Hand pulling is most beneficial in the Spring and early Summer when the soil is moist and the plants are fairly small. Both of these herbicides are restricted use compounds. Be sure you have the proper license or use licensed personnel to do the application. **Both of these herbicides are restricted use compounds.**

CHEMICAL RECOMMENDATIONS – WOODY PERENNIALS – NON-BOG USE ONLY!!

Weedone CB	Do not dilute.	Apply in February and March. Spray to wet. Avoid drift onto bog. Controls woody plants on roadsides and non-crop areas. It is no longer produced, but available product may be used <u>off the bog</u> .
Crossbow	up to 2 gal/A	Mix with enough water to deliver 10-30 gal/A. Application rates vary depending on target species and application method. Drift to desirable plants may cause injury (esp. grapes and tomatoes). Do not apply to water. Read the label! See Notes on 2,4-D.

DITCH MANAGEMENT

WOODY AND BROADLEAF PERENNIALS ON DIKES (BOG-SIDE).

Cultural controls include mowing the ditch and dike areas during the summer months. Some areas may need to be done more than once. Hand pulling is most beneficial in the spring and early summer when the soil is moist and the plants are fairly small. Controlling weeds on the dikes may be useful in reducing spread of these weeds onto bogs.

DITCH WEEDS (*e.g., Arrowhead, Pickerelweed, Pond lilies, Bur-reed, Duckweed*)

Clean ditches by hand or mechanically preferably twice a year. Draining ditches can sometimes be helpful in killing some aquatic weeds (*e.g., duckweed*). Preemergence herbicides registered for use on the bog may **NOT** be used in the ditches for weed control.

DITCH WEEDS - CHEMICAL RECOMMENDATIONS

Roundup WeatherMAX	Use as a <i>wipe</i> or <i>spray</i> during the Summer months in dry ditches. See Notes on Roundup.
	Spray: Use a 1-1.5% solution on a volume-to-volume dilution. Spray to just wet vegetation, not to run-off. Ditches must be kept dry at least 2 days after application.

CAUTIONS AND OTHER NOTES

1. Chemicals not registered for use on cranberries must not be used.
2. Herbicide use may weaken vines and crops may be reduced.
3. To be most effective, rain should follow the application of any dry herbicide formulation within 4 days or the bog should be irrigated.
4. Wash equipment with soap (or detergent) and water immediately after using. Rinse with ammonia after using hormone-type herbicides (such as 2,4-D).
5. Hand wiping with glyphosate products is often practical with some weeds if roots are weakened. This is particularly useful for dewberries after late water or a summer flood.
6. Mowing of tall weeds helps to prevent shading and reduces seed formation.
7. Late water causes general reduction of annual grasses and may reduce dewberry populations and re-growth.
8. Agricultural burning of brush or grass is allowed under regulations from the Director of Air Pollution Control, Southeastern Office of the Dept. of Environmental Protection and under permit from the local fire chief.
9. Review the Weed Management BMP in the UMass Best Management Practices Guide. <http://www.umass.edu/cranberry/pubs/bmps.html>.

NOTES ON THE USE OF COMMON HERBICIDES

CALLISTO (Mesotrione). Since Callisto interferes with photosynthesis, affected plants will turn white. Injury may take several days or weeks to show. Allow a minimum of 14 days between applications. Hardier weeds will likely need 2 applications over a period of successive years for control. Callisto should work well against crabgrass but is weak against foxtails. Callisto is rain-fast in less than 4 hours and has no known bee issues. Callisto can be applied in low volumes of water (if so desired) with no loss of efficacy; just be sure to get good coverage. If you want to add a dye to the herbicide mix, the manufacturer recommends using Spray Tracer; they recommend AGAINST using Blazon Blue (this product is NOT labeled for food crops). NIS and COC should work equally well with Callisto; however, some COC may cause injury on cranberry, so stay away from these products.

Use on New Plantings. Data from MA and WI indicate that Callisto is an excellent choice for use on newly planted vines. Growers have first applied Devrinol (within 3 weeks of planting) and then follow up with one or two Callisto applications; this combination seems to have worked well. No injury has been reported. Lower rates are often a good choice as many of the early weeds are grasses or annuals.

Resistance Management Concerns. Resistance to Callisto has been reported in other crops after only 7 years of use. It is important that we do not lose this tool for dodder and general weed management. Occasionally rotate Callisto out of your herbicide sequence and substitute other herbicides. Use non-chemical forms of weed control every when possible. Do not use Callisto repeatedly year after year.

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CASORON (Dichlobenil). Applications of Casoron are most effective when applied as close to the time of weed germination or emergence as possible. Since Casoron volatilizes quickly, it must be washed in by irrigation or rainfall ASAP after application. Avoid applying during warm temperatures (air T >60°F). Apply pre-budbreak or post-harvest. Application just prior to sanding or on weak or new vines may cause injury. Applications on top of sand or late applications can be made, but must be watered in *immediately*. Low rates (<40 lb/A) may be applied after removal of a late water flood to control dodder with minimal risk of phytotoxicity. In general, applications of preemergence herbicides are not recommended *after* the late water flood is withdrawn.

Casoron may be applied by air or by ground equipment. Multiple applications may be made as needed. Allow an interval of 3-6 weeks between applications. Do not exceed 100 lb/A in any 12-month period. Single doses of high rates of Casoron may be needed to control some perennial weeds. However, some weeds are not controlled by Casoron at any rate due to their deep root systems. Cranberry vines with weakened root systems are more susceptible to stresses such as drought and may become more stressed with herbicide application. Some vine injury may occur from herbicide applications made in areas where puddling is a problem.

Distribute Casoron uniformly. Avoid overlapping of herbicide. Temporary reddening of vines may occur especially with late spring application or when applied on sandy bogs. Do not apply after bud elongation as vine injury may occur and yields may be reduced. Do not apply to young beds (less than 3 years old unless root systems are well established) or on bogs prior to or immediately after mowing vines. Do not sand (spring or fall) on top of a Casoron application. Casoron is labeled for application in the fall prior to ice sanding that winter or in the spring after ice sanding. The efficacy of fall applications for many weeds has not been documented, but growers have reported good success in some cases.

Efficacy of Casoron may be reduced if irrigation to protect from frost (or other reasons or rainfall) follows application. Less than 0.5 inch of water will likely not affect efficacy but more than 1 inch probably will. The herbicide zone will widen to more than 6" and will miss many of the emerging weeds or seeds. Organic matter helps to retain the herbicides but MA are typically low in OM (<2%).

COPPER SULFATE and COPPER COMPLEXES (Algae-Pro, Cutrine-Plus). Copper sulfate may be used to control algal growth on winter or late water floods. Cutrine-Plus and Algae-Pro work best when water temperatures are warm (~ 60°F). These copper-complex products are formulated to last longer than copper sulfate in hard water (carbonates present). Copper-complex products work best when applied under calm and sunny conditions.

If you are holding a 4-week late water flood, plan to apply a copper product mid-way through the flooding cycle (for more details, see Prevention of Scum in the Late Water section). These products are typically applied directly through the irrigation systems (with heads on risers). For winter floods or late water floods of short duration, scout for algae and apply when growth is first visible on the water surface. Remember, these products only prevent further algal growth; they do not kill or remove what has already grown. Crystal copper sulfate will dissolve easily in water and can be applied as a spray solution. Though somewhat uncommon now, crystalline products can be placed in burlap bags and dragged across the water surface. When bogs are treated with copper sulfate during the winter months, water should be impounded for one week. Since late water floods tend to be warm, there is no need to impound these waters. Do not apply to water except as directed on the label. These products are toxic to fish. Do not use any other algaecide products; consult with the Weed Specialist if you have any questions.

Nautique is a copper carbonate (double-chelated copper formulation) product that can be used to control certain aquatic plants in irrigation systems (ditches, canals) in crop systems. It is highly corrosive and carries a DANGER label. It may be fatal if absorbed through the skin. Be very careful with this product!! Wear all recommended protective equipment. Fish toxicity is dependent on the hardness of the water; in

soft water, trout or other fish may be injured or killed. Do not use if carbonate hardness of the water is less than 50 ppm. If applying to public waters, check with the local authorities for permit process. Nautique can be mixed with other aquatic herbicides; check the label. When applying to irrigation ponds, hold water for a minimum of 3 hours before irrigating plants.

CROSSBOW, WEEDAR 64, WEEDONE CB (2,4-D). Crossbow and Weedone CB are labeled for **non-bog use only**. Be cautious! Crossbow contains trichlopyr for which there is **no food tolerance**. Do not use Crossbow or Weedone CB on dikes or canal banks. Use it only on weeds located far away from the bog. These products have considerable potential to evaporate and cause crop injury. Avoid applying 2,4-D on hot, sunny, and humid days when there is little air movement. Weedar 64 is the only 2,4-D product that can be used on the bog. 2,4-D products can be highly effective at controlling some weeds. However, the potential for significant vine injury may outweigh the advantages of using these materials. Weedar 64 has a 30-day PHI and may only be applied once per season. **Weedar 64 is a State-restricted use product!!**

DEVIRINOL (Napropamide). Devrinol 50DF is available (24c label) for use on cranberries. Unlike Devrinol 10G, the new formulation can be injected through the irrigation system. Be sure to run the system after application to ensure that the herbicide is washed off the leaves and gets to the soil. 50DF seems to perform at least as well as Devrinol 10G, if not better in some circumstances. Be sure to get the supplemental label at the point of purchase. Since Devrinol will control grasses, give careful consideration to use of 50DF if you are establishing ditch banks and your irrigation system delivers coverage to the ditch bank area. Be aware that UPI has discontinued production of 10G.

Up to three 6-lb/A applications or 2 9-lb/A applications of Devrinol 50DF may be used on new plantings but the maximum doses may not be necessary in many instances (depends on weed pressure and availability of labor). On established bogs, this herbicide provides some control of grassy weeds and annual broadleaf plants at higher rates (50DF: 12-18 lb/A; 10G: 60-90 lb/A for peat beds; 8-12 lb/A 50DF; 10G: 40-60 lb/A; for mineral soils), but works best on weed free areas. Rate differences for the soil types (higher rates with more OM) are primarily due to efficacy issues rather than toxicity or groundwater concerns. The top 2-4 inches of soil should be moist. If the soil is dry, irrigate soon after application. If the soil is already moist, the need is not as urgent. 50DF can be chemigated (10G may be applied by air or ground). Use the appropriate rate for the age of the bog. Devrinol can be used under or on top of sand.

DIQUAT. This herbicide should only be used on water weeds growing in areas OUTSIDE OF THE BOG. Do not use in any ditch associated with the production area. Diquat will control water weeds such as bladderwort, coontail, elodea, and pondweeds. A non-ionic surfactant (e.g., X-77) may improve performance. Check the label for rate information.

EVITAL (Norflurazon). Vine injury may occur in areas where water stands several days after flooding or heavy rains. Do not apply more than 160 lb/A per season on an established bog. Use lower rates on stressed vines or sensitive cultivars such as Stevens and McFarlin. Growers have reported good results with low rates (50-75 lb/A) for fall applications on these varieties; spring applications should not exceed 60 lb/A. Sanding can be done on top of an Evital application, but it is not recommended especially on bogs that have drainage problems. Sanding after applications of 50 lb/A or less has given good results. Growers have reported that applications of Evital (50-60 lb or less) on top of sanded vines work adequately on healthy well-drained beds.

Be conservative when applying Evital to new plantings! Usually, new vines are very sensitive to Evital. However, growers have reported using 35 lb in the fall on Stevens that were planted in the same year with good success. In other instances, vines have shown severe phytotoxicity to rates as low as 25 lb/A when applied 3-4 weeks after planting.

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FUMIGANTS. Basamid (dazomet) and Vapam (metam-sodium) are soil fumigants that can be used on cranberry beds. **DO NOT USE FUMIGANTS AS A SPOT-TREATMENT IF ANY VINES WITHIN A DIKED SECTION WILL BE HARVESTED.** If you are renovating an entire section, a portion of that section can be spot-treated with a fumigant. More information on the use of fumigants may be found in the New Plantings Fact Sheet (available at the Station).

IRON SULFATE. May be spread as a broadcast application through conventional fertilizer rigs, such as hand cranks. Traditional use has been with a 20% ferrous sulfate (fine powder) product, but other formulations are available. Application rates listed in the Chart Book are for the 20% a.i. product. Adjust accordingly if using another percent active ingredient. Iron sulfate at rates exceeding 1.1 oz/sq. ft (20% a.i. product) may kill vines if they have been sanded within the past 18 months. Do not use on new bogs. To be most effective, rain should follow within 4 days of an iron sulfate application or the bog should be irrigated. When a 9:1 iron sulfate to salt combination is used, rain or sprinkling is not necessary.

POAST (Sethoxydim). This herbicide effectively controls emerged annual and some perennial *true grasses*. Sedges are not controlled. It may be used on bearing and non-bearing beds. There is a 60-day PHI on bearing beds. Do not apply more than 5 pints (80 oz) of product per season. Allow a minimum of 14 days between repeat applications. Phytotoxicity may result if the herbicide is applied during the heat of the day or during bloom. Application during cool periods of the day, but after dew has dried, is preferable. If you have never used this material before, it may be wise to test a small area before applying the product to a larger area.

Efficacy is enhanced by addition of crop oil concentrate (COC) or Dash HC; an adjuvant should always be used. Other adjuvants may reduce efficacy or increase crop injury. Since COC or Dash HC can be mildly phytotoxic, Poast should not be applied during periods of crop stress or during flowering. Poast should not be mixed with other chemicals, particularly chemicals whose label warns against inclusion of an adjuvant.

Poast must be absorbed into the grass to be effective. Therefore, do not apply Poast if rainfall or irrigation is expected within one hour of application. Poast should be applied when grasses have 6 to 8 leaves to provide enough leaf surface for absorption. Apply Poast to grasses that are actively growing and free of stresses such as drought, disease, or mechanical injury.

POAST CANNOT BE APPLIED THROUGH THE IRRIGATION SYSTEM! Spot treatments with small sprayers are effective. **For one gallon Poast solution, mix 2 oz of Poast with 0.6 oz of Dash HC (or 1.3 oz of crop oil concentrate) in 1 gallon water.** Thoroughly wet the grass foliage, but do not let the solution run off the leaves.

Broadcast Application. Use standard high-pressure hollow cone or flat fan nozzles only. Use 5-20 gal of spray solution per acre at 40-60 psi. Inadequate coverage of grasses due to heavy cranberry canopy may reduce control. Do not use re-circulating sprays, wiper applicators or shielded applicators. Use of Poast with control drop application is not recommended due to erratic coverage. *Aerial Application.* Do not apply if wind speed is greater than 10 mph.

Use on New Plantings. Poast can be safely used on newly planted vines. Wait for roots to develop before application. Growers report mid-July applications approximately 6 weeks after planting worked well. Grass control was enhanced when Poast applications were followed by Callisto applications.

REGLONE (Diquat dibromide). Reglone should only be used on bogs that will be renovated or will not be harvested for 1 year. The intended use is as a site-preparation product, not for use for spot weed control on an active farm. This product works as a plant desiccant and should be used as a directed spray. Reglone cannot be applied by chemigation.

RODEO. This glyphosate product can only be used to control weeds that occur in dry ditches and canals outside of the production area. Application is spray to wet leaf surfaces, not to runoff. Extremely cool or cloudy weather following application may slow the activity of this herbicide. Best control is obtained when plants are at late growth stages approaching maturity. Weeds under stress will not be controlled as well as healthy plants. Rainfall within 6 hours of application may reduce effectiveness and heavy rainfall within 2 hours of application may necessitate reapplication. Do not add ammonium sulfate to Rodeo mixtures.

ROUNDUP (Glyphosate). Many Roundup and glyphosate products are available on the market. Please read the label of any product you are using to ensure compliance. This product may be applied on bogs, by wiper or clipper, during the growing season. If you are using Roundup Ultra, you will need supplemental labels for dry ditch and postharvest sprays. If you are using WeatherMAX, these spray uses are incorporated into the label and additional labels are not needed. WeatherMAX is slightly more concentrated than Ultra, so keep that in mind when preparing solutions. Use 1%-1.5% solutions (2.5-3.8 Tbsp or 38-57 ml/gal) for dry ditch applications and 0.4%-0.7% solutions (~3.0-5.5 tsp or 15-27 ml/gal) for postharvest sprays. Recent research indicates that Howes may be slightly more sensitive to postharvest spray injury than Early Black.

It is not necessary to mix Roundup Ultra or WeatherMAX with any additional surfactants or additives (as with older glyphosate products). Add a dye to track leaf coverage. Technical information indicates that ammonium sulfate may improve uptake of these Roundup products when moderate to large amounts of carbonates ('hard water') are present in water (rarely a problem in MA). Roundup WeatherMAX is rainfast 1-2 hours after application. Available glyphosate products vary as to whether they carry a 'Caution' label or 'Warning' label. Look at the label!! When using Roundup, protective eyewear is not mandated; the REI for WeatherMAX is 4 hours. Thorough coverage is essential to maximize control of perennial weeds. Do not touch or allow material to drip onto vines. **Apply any time weeds are present except 30 days before harvest.** Make herbicide mixtures fresh each day for maximum effectiveness. Do not store in galvanized containers.

Roundup Products	Mix 1 part glyphosate with 4-9 parts water (10-20% solutions). No additional additives, buffers, or surfactants are needed. However, the addition of ammonium sulfate may sometimes improve performance.
+ A marker dye (e.g., Spray Tracer)	Add according to manufacturer's recommendations.
Glyphosate products	Mix 1 part glyphosate with 4-9 parts water (10-20% solutions).
+ Surfactant	1 oz (2 tablespoons) per gallon of glyphosate mixture.
+ Ammonium sulfate	3 oz (6 tablespoons) per gallon of glyphosate mixture.
+ A marker dye (e.g., Spray Tracer)	Add according to manufacturer's recommendations.

OTHER GLYPHOSATE PRODUCTS. Glyphosate is sold under several product names. **CHECK THE LABEL!** To enhance control with glyphosate products other than Roundup WeatherMAX, add a nonionic surfactant (e.g., X-77) and ammonium sulfate (see rates above). Other label differences include: Do not apply if rainfall is expected within 6 hours of application. Do not irrigate within 6 hours of application. The REI is 12 hours for these products. Note also that glyphosate products other than Roundup WeatherMAX may carry a 'Warning' label, instead of a 'Caution' label. Always use a dye to track your coverage with any wipe product. Check the label for appropriate protective clothing.

Clipper Applicators (Roundup only). Concentrations of 50-100% Roundup have worked well. The herbicide should flow out consistently, but not so fast that herbicide drips from the blades. Be sure to use a dye. Clip weeds close to the ground, without contacting the vines. Roundup must contact the stem as you are cutting! 'Clip and dab' or 'mow and wipe' techniques may have reduced efficacy as the herbicide is not applied simultaneously with the cut. Late-season treatments give better results than early-season treatments. The effectiveness of post-harvest treatments with clippers is not known. Be sure to clean the blades after use to

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prevent corrosion. Availability of commercial clippers has become more scarce over the past few years. Growers may need to manufacture their own clippers.

General Wiping Tips. Use a small sponge or applicator that permits excellent coverage with minimal dripping. Adequate coverage of each stalk must be obtained. Several leaves (at least 50%) on each stalk must be treated with the herbicide. Repeat applications to remaining plants the following year. Be patient. Most treatments will not give 100% control in the first year. Applications in subsequent years should be less time-consuming.

Hand wipe Technique for Controlling Dewberries or Other Weeds that Lay in the Vine Canopy. Application by hand with sponges or specially designed applicators may be necessary with low-growing weeds (e.g., bristly dewberry, poison ivy). Repeat applications within a season are legal and may be necessary, especially for well-established perennial weeds. Poor growing conditions such as drought stress, disease, or insect damage may reduce effectiveness. Avoid touching or dripping material onto cranberry plants during application. Some growers have had success staking the vines (tomato stakes or similar) for wiping and allowing them to dry prior to laying them back on the vines. This certainly reduces vine injury.

SUPPLEMENTAL LABEL USES. Supplemental labels may be needed with certain Roundup products when doing post-harvest sprays (0.5%-1%), applied as a spot-treatment, or sprays in dry ditches (1%-2%); these uses are included in the regular labeling for WeatherMAX, PowerMAX, and OriginalMAX. CHECK THE LABEL of the product you are using. Generic glyphosate products do NOT have supplemental use labels.

SALT. Salt (sodium chloride) may be used as a spot-treatment for control of certain weeds (e.g., wild bean, rushes). Judicious applications do not inhibit re-colonization of cranberry vines once the weed dies. Do not use during bloom. Use of calcium chloride or other types of salts is not recommended. Salt is corrosive to machinery. Be sure to wash equipment thoroughly after application.

SELECT (Clethodim). Similar to Poast with regards to target species, timings, and applicators. Note these differences. Apply when weeds are 2-6 inches high and actively growing (check label for specific heights for each target weed). Multiple applications are typically needed for perennial weeds. Results are best when weeds are not under stress. Irrigation should follow within 7 days if rainfall does not occur. Use of a non-ionic surfactant (NIS) is recommended with Select Max. For a 1-gal mixture, use 1.3 Tbsp Select MAX with 0.65 Tbsp NIS. Select Max has a 30-day PHI. Do not apply more than 16 oz Select MAX per application per acre. Do not exceed 64 oz/A/season. Allow 14 days between applications. You can use 3-10 gallons water with aerial applications, 10-30 gal/A otherwise.

STINGER (Clopyralid). Stinger is a selective, postemergence herbicide used to control wild bean, narrow-leaved goldenrod (NLGR), asters, clover, ragweed, pitchfork (and other members of the Composite and Legume families), and certain other weeds within the treated area. Growers have reported effective control (and reduced vine injury) when using lower rates than recommended on the label. This is particularly true for wild bean control.

Apply when weeds are actively growing. It is best to apply Stinger when vines are dormant, if possible. For weeds that emerge late (NLGR, wild bean, etc.), wait until after fruit set to apply. It is not recommended to apply Stinger when vines are going through active growth spurts (e.g., budbreak-roughneck stage). Stinger has a 50-day PHI. Stinger may be applied as a wipe or as a spray. Spray to just wet the weeds, but not to run-off. BE VERY CAREFUL! Overspray can cause injury that may take 1-3 years for full vine recovery. Minimize drift when applying as a spray. Results may be slow to show; be patient. Two applications per season are permitted, not to exceed a total of 1 pint per acre. Stinger cannot be applied by air or through the irrigation system.

SULFUR. Determine soil pH in the weedy area prior to sulfur application. If pH is 5.0 or above, use two applications of 500 lb/A each (or 4 applications of 250 lb/A) to reach 1,000 lb. of elemental sulfur per season. Begin application in late spring when soil is drained and sprinkling for frost is over. Most growers allow 3-6 weeks between applications. Do not apply sulfur to puddled or waterlogged areas as resultant production of hydrogen sulfide can cause severe vine toxicity. Changes in pH can be very slow. Granular applications may take up to nine months to reduce pH enough to affect weed populations. The smaller the sulfur pellet size, the faster the pH is lowered. Use pelletized sulfurs only. Do not use flours of sulfur; they can be phytotoxic and are difficult to apply. Do not use potassium sulfate. Yearly sulfur applications may be needed as the pH can creep up in subsequent years. Test soil pH yearly to determine the effectiveness of sulfur applications. The effect of lowered pH on control of cinquefoil is moderate. Eye protection and dust masks are recommended when making sulfur applications.

ADJUVANTS. These products are added to a pesticide mixture to improve its physical qualities and its effectiveness and includes surfactants, stickers, penetrants, compatibility agents, etc. Pesticide labels may list specific types of adjuvants that will maximize effectiveness of the pesticide. Be sure to use the proper category of adjuvant if the manufacturer makes a specific recommendation.

Nonionic surfactants (NIS) spread the spray droplet evenly over the leaf surface and help it adhere to the leaf. It increases penetration of the herbicide through the leaf cuticle. Common commercial products include LI-700 or Activator 90 (replaced X-77). Crop oil concentrates (COC) are also nonionic. They may consist of petroleum, vegetable, or methylated vegetable or seed oils (along with a surfactant) designed especially for use in agricultural pesticide spray programs. Many COCs are available and may be sold as Crop Oil or under other trade names such as Herbimax. COCs tend to be less expensive per gallon but you typically have to use more product per acre.

Insecticides and fungicides may also require the addition of an adjuvant, so check the label!

Materials used for a dye test (e.g., Hi-Light) are not adjuvants and should not be mixed with pesticides.

NOTES ON CONSERVATION SEED MIXES FOR DIKES AND DITCHES

Several criteria were used to compose the seed mix recommended by Plymouth County Conservation District. The seed mix needed to contain perennial species, must contain at least one nitrogen-fixer, must be drought-resistant, must not introduce known weed seeds, contain at least 3 species and be economical to purchase. The current seed mix is creeping red fescue (39.7%) with a germination rate of 85%; perennial ryegrass (34.2%) with a germination rate of 90%, empire birdsfoot trefoil (24.5%) with a germination of 70%, and 5% hard seed and some inerts. For more information on planting rates and cost, please contact the West Wareham office at 508-295-5495.

NUTRITION MANAGEMENT FOR PRODUCING BOGS 2012

Prepared by Carolyn J. DeMoranville

MANY GROWERS HAVE SUCCESSFULLY IMPLEMENTED PHOSPHORUS (P) REDUCTION USING 10 LB/A OR LESS. USE NO MORE THAN 20 LB/A P UNLESS A DEFICIENCY IS DOCUMENTED.

IMPORTANT CONSIDERATIONS REGARDING P USE AND REDUCTION:

Research in Massachusetts and Wisconsin has shown that cranberries require additions of phosphorus fertilizer for sustained productivity. However, there is no evidence in *any* research plot work or commercial bed observations that more than 20 lb/A actual P is required for productive cranberries. In some studies on high P sand soils, there was no response to P fertilizer on beds with adequate tissue P. In other studies, on native cultivars, the greatest yields were on plots receiving 10-15 lb/A P, with no improvement at higher rates. The only exceptions to the “not to exceed 20 pound” recommendation are beds with documented deficiencies (tissue P <0.1%) or new beds with fresh sand planting medium (the recommendation for those is to use up to 20 lb/A at planting and no more than *a total* of 30 lb/A for the first season on new or renovated beds).

P can be an environmental pollutant. Adverse environmental impacts are reduced by using moderate P rates (no more than 20 lb/A per season) and by careful attention to harvest flood management. When bogs are flooded, especially when soil and water are warm, P that was previously bound to iron in the soil can be released into the flood water. When that flood is released, the dissolved P then leaves the bog system.

To minimize P release in harvest floods: 1) Hold harvest floods for 2-4 days to allow settling of P-containing particles, then release gradually (to avoid flushing particles) so that all water is discharged within 10-12 days. Research has shown that holding floods beyond 10-12 days in the fall results in oxygen depletion and release of P from iron in the soil. 2) Use no more than 20 lb/A P in fertilizer -- research shows that with high P use, P movement into the flood begins immediately upon flooding and then accelerates as oxygen depletes. With low to moderate P use, P release into water is minimized in the first 10 days.

Based on production research, 20 lb/A P is sufficient to maintain productivity if tissue test P is in the sufficient range (0.1-0.2%). In fact, in plots and demonstration sites, production was maintained with less than 20 lb/A. As P fertilizer use was reduced, P output from the bog (in water) also decreased. Based on these studies, growers have reduced P applications **below** 20 lb/A (5-year rolling average of ~10 lb/A). When implementing such reduction, it is important to collect August tissue tests and follow these recommendations: If P is <0.10% - increase P rate and retest next season; if P is 0.10-0.11% - maintain P reduction and retest next season; if P is 0.12-0.15% - maintain P reduction and retest in 2-3 years; if P is 0.16% or more - further reduction should be considered.

PLANT APPEARANCE

Decisions regarding nitrogen (N) rate for a cranberry bog should be based in part on the length and density of uprights. By mid-June (hook stage), the minimum total growth on the new uprights should be 2.25 inches for 'Early Black' and 'Howes', and 2.5 inches for 'Ben Lear', 'Stevens', and other hybrids. Flowers on uprights longer than 4 inches may be poorly pollinated and fruit poorly colored. Flowering uprights should have 1.5 to 2 inches of leafy length above the flowers and fruit. Presence of adequate foliage (length) by mid-June is significantly correlated with yield later that season. Small, stunted uprights early in the season are associated with poor crops. The average upright density for a productive bog should be about 600 uprights/sq. ft. for 'Early Black' and 400 uprights/sq. ft. for 'Howes', 'Ben Lear', and 'Stevens'. Ideally, 200 or more of these uprights should be the flowering type. An adequate stand of vegetative uprights is also important, as about 80% of these will flower next year. Even and adequate vine cover is the key to good production: 200 flowering uprights/sq. ft., each producing an average of 1 berry, will give a crop of 200-300 bbl/A. To sample upright density: count all uprights in a circle 4 inches in

diameter. Total upright density (approximate) for 'Early Black' should be 50/sample; density for 'Howes', 'Ben Lear', or 'Stevens' should be 35/sample.

Leaf greenness is related to the pigment, chlorophyll, that is involved in carbohydrate production through photosynthesis. Along with adequate growth (length) of the uprights, chlorophyll content is an important determinant of yield. Overall intensity and shade of leaf greenness (chlorophyll) is related to adequate N nutrition. With experience, growers can assess intensity of greenness by visual observation.

A bog with thin vine cover, pale leaves, or stunted vines may not be getting enough nitrogen. Remember also that vines that are too long and too dense are related to diversion of nutritional assets to vegetation (small berries), poor fruit color, increased fruit rot, and inability of bees to reach pollination sites.

Yellow Vine (YV) manifests as an apparent nutrient deficiency. Beginning with older leaves, yellowing presents along leaf margins and between the veins on the leaf, leaving green only along the veins. Tissue tests of such leaves often show higher than standard potassium and low-normal magnesium. However, extensive investigation has shown that the nutrient imbalance is *secondary* to the primary problem – root insufficiency due to too much or too little moisture. Cranberry bogs with patches of YV were found to have soil water content (in the YV areas) that was either much higher or much lower than that in the surrounding green areas. Additionally, in greenhouse experiments, plants subjected to very shallow or very deep water table conditions developed YV. The consistent finding in the field has been that the rooting depth in YV areas is shallower than that in unaffected areas. In most cases, YV appears in areas that were too wet early in the season leading to poor rooting depth. Rooting depth can be improved by keeping the bed well drained early in the season. When the water table is closer than about 6 inches below the surface, root development and root function is impaired. Examine your drainage and irrigation practices if you see YV on your bog. Another symptom of poor drainage is high manganese (Mn) in the tissue test. YV usually appears as temperature and water stress increase during mid-summer and may be more severe if Casoron has been used since this herbicide can affect rooting and root function.

SOIL AND TISSUE TESTS

Soil and tissue tests are tools that a cranberry grower can use for several purposes. These include: (1) diagnosing deficiencies of mineral elements; (2) monitoring soil pH; and (3) aiding in the decision making process for choosing fertilizer (tissue tests). Soil and tissue tests are important for these reasons. However, there are no 'cookbook' type formulas for fertilizing a cranberry bog based on the test results. There are several reasons why such an approach will not work for cranberry production: (1) standard soil tests poorly predict availability of nutrients and poorly correlate with yield in cranberry; (2) as a perennial plant, cranberries store nutrients from the previous season(s) making it impossible to base fertilizer choices only on soil content and yield potential; (3) there is virtually no variability in soil test N values from bog to bog; (4) tissue test N concentration may vary depending on length of upright (N concentration in the tissue does not always correlate well with added N); (5) nutrient availability changes with soil pH and soil pH is not uniform from bog to bog; and (6) common soil test methods for P do not give results that correlate well with cranberry yields due to very acid soils in cranberry production – standard P tests are of no value if soil iron is above 200 ppm.

With these warnings in mind, tissue and soil analyses can be beneficial as a long-term record of changes in your bog. Soil and tissue tests are particularly useful when compared to one another - a soil test alone is virtually useless in determining a fertilizer recommendation for cranberry. Tissue tests are more useful for setting target fertilizer ranges. We recommend sampling every 3-5 years for soil, every 2-4 years for tissue (but see also P use and P reduction section above). Keep the results and use them in conjunction with your records of your bog management and performance (growth and cropping) to aid in making fertilizer decisions. Use periodic soil testing to monitor any change in soil pH. For further information regarding tissue testing, refer to "Cranberry tissue testing for producing beds in North America" fact sheet (available at: http://scholarworks.umass.edu/cranberry_factsheets/6/).

When and how to test

The results you receive from a soil or a tissue test are only as good as the sample you supply to the analytical lab. It is important to remember that the sample that you submit for testing for nutritional elements is not the same as the sample you would collect and submit for other purposes (e.g., the

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diagnosis of a disease). Soil can be collected into 1 qt zipper plastic bags; tissue should be collected into paper bags. Some analytical labs supply collection bags. Remember, a properly collected and handled sample of soil or tissue is essential to an accurate analysis. Collect one composite sample for each management area as instructed below. A management area may vary in size but will be all one variety that is treated uniformly, often under one sprinkler system.

Tissue samples: Samples for cranberry tissue analysis should NEVER contain roots, soil, runners, fruit, or trailing woody stems. In general all of these contaminants contain less nutrients than the upright tips. Including them will give a falsely low analysis. Tissue samples are best collected from **mid-August to mid-September**. Samples collected at that time should include **upright tips only** (do not strip off the leaves). Collect no more than the **top 2 inches** of new growth (mix flowering and vegetative uprights). As you walk a transect across the bog, collect enough material to make about 1 cup. You may collect directly into marked bags as samples should not be washed. Collect samples when the plants are not wet. Do not mail samples in plastic bags. Moldy samples give poor results. Always request nitrogen determination. This increases the cost, but nitrogen levels in the tissue test are an important indicator of plant status and the success of fertilizer programs.

Sampling other than in August-September: Tissue samples may be collected at other times of year if absolutely necessary. However, nutrient levels change more rapidly outside of the recommended time and make interpretation of the results more difficult. If sampling in the spring, samples should be collected in June and consist of **new upright tissue only**. Do not include last season's leaves - they will lead to a falsely low result. *In June samples, nitrogen should be 1.2-1.5%, phosphorus 0.15-0.19%, and potassium 0.7-0.9%.* Call the Cranberry Station for interpretation of other elements.

Tissue samples should be collected when deficiency is suspected or diagnosis of a specific problem is needed. For problem diagnosis, collect 2 separate samples - one from the problem area, and one from nearby 'normal' vines.

Samples collected after mid-September give lower analysis values than those collected earlier. This is especially true for nitrogen (it is transported out of upright tips and stored in older tissue as dormancy approaches). Also, late in the season the uprights become more woody so that more of a tip sample is stem tissue. Stems have less nutrient content than do leaves so the overall result is a lower analytical value.

TISSUE STANDARDS (August 10 to September 15 collection)

These standards were developed in conjunction with researchers throughout the cranberry growing areas of the United States.

Major Element	Concentration in dried tissue <i>percent</i>	Minor Element	Concentration in dried tissue <i>ppm</i>
Nitrogen (N)	0.90-1.10 *	Boron (B)	15-60
Phosphorus (P)	0.10-0.20	Zinc (Zn)	15-30
Potassium (K)	0.40-0.75	Copper (Cu)	4-10
Calcium (Ca)	0.30-0.80	Iron (Fe)	problem if less than 20
Magnesium (Mg)	0.15-0.25	Manganese (Mn)	problem if less than 10, if greater than 500-600, check bog drainage
Sulfur (S)	0.08-0.25		

* = As high as 1.3 % has been seen for Stevens, but monitor growth closely if N is > 1.1 %.

Soil samples: Samples for analysis of soil nutrients should NOT contain stems, leaves, or the surface duff layer (trash). These are all organic contaminants and will bias the organic matter (OM) determination for the sample. The inclusion of some roots is generally unavoidable. Use a soil probe with a 1-2 inch diameter to collect cores of 4-6 inch depth. Minimum requirements: 4 cores for up to 1 acre; and 1 core

for each additional 2 acres up to a total of 10 cores/bog. After the trash layer on the surface of each is discarded, these cores are combined to make a sample. Collect enough soil to fill a 1 qt plastic bag about $\frac{3}{4}$ full. At home, open the bags and dry the soil at room temperature for a day or two. The resulting sample will weigh less and cost less to mail. Clearly mark each sample bag. OM determination (usually an additional charge) is often useful. Methods of analysis vary by lab - pick a lab and stick with it. The Bray test for soil P is the most commonly used in the eastern United States. However, this test, like all common P soil tests, is of limited value in cranberry soils. The best time to sample cranberry bogs is when the soil is not waterlogged. Wet soils give falsely high P values. Soil samples may be collected with tissue samples in the late summer if no sanding is planned. Otherwise, sample soil in the spring.

UMass provides soil and tissue analysis services at the Amherst lab for a fee. Submission forms for this lab are available at the Cranberry Station. Also see their web site for downloadable forms and schedule of fees (<http://www.umass.edu/plsoils/soiltest/>).

CONVERSIONS FOR SOIL TEST RESULTS

lb/A K, Ca, Mg or P	divide by 2.27 to get ppm
lb/A K ₂ O	divide by 2.75 to get ppm K
lb/A P ₂ O ₅	divide by 5.2 to get ppm P

SOIL STANDARDS (ppm)

Ammonium acetate extraction unless otherwise indicated.

Element	Deficient below	Normal	Excess above
Phosphorus (Bray)	20	20-60	80
Phosphorus (P)	4	4-9	10
Potassium (K)	10	10-40	50
Calcium (Ca)	20	20-80	90
Magnesium (Mg)	10	10-25	25

pH 4.0-5.0

Base saturation: Ca should roughly equal the sum of K and Mg.

Base saturation is the *proportion* of the various positive cations in the soil. In acid soils 45-70% should consist of hydrogen ions (these replace much of the Ca that would be found in higher pH soils).

Cation Exchange Capacity (CEC): Measures ability of soil to hold positive ions (cations or bases). If CEC is low (<10), base saturation proportions are important. If CEC is high and all cations are in the normal range, the proportions in the base saturation are less critical.

If soil iron is above 200 ppm, soil P tests will not accurately reflect P availability.

MAJOR ELEMENTS

NITROGEN, PHOSPHORUS, AND POTASSIUM (NPK):

Most often these elements are added together in 'complete' NPK fertilizer. The amount to apply depends on the desired N rate. When low N rate is required (generally pre-bloom), low N materials (e.g. 5-5-20) or Zero-N materials (foliar P/K or SulPoMag, for example) may be used.

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When choosing fertilizers, remember that research indicates there is no horticultural benefit to high P rates (in excess of 20 lb/A actual P per season) and that high P applications can be associated with degradation in water quality. If tissue P is in the sufficient range, we do not recommend fertilizers with high P (middle bag number). In fact, excellent results have been seen in recent years with 1:1 or near 2:1 N:P ratios (for example, 18-8-18). **It is highly recommended that growers use reduced P ratio fertilizer on their bogs, especially if high N applications are planned.**

N rate is chosen based on vine appearance, tissue test, soil type, previous response and yield, and weather (spring temperature). Based on bog history - use the lowest N rate that gives adequate vegetative growth and maintains productivity. A nitrogen rate of 20-25 lb/A (higher for Ben Lear, Stevens, and other hybrids) for the season is a reasonable starting point if you are unsure about rate.

Soil balance of K, Mg, and Ca is important. Excessive use of any one can induce deficiency of the others. This is especially a risk with high Ca use. Lime can have adverse effects by changing soil pH. Since materials high in chloride (Cl) may lead to decline in production, avoid use of high rates of 0-0-60 or products containing potassium chloride as the K source.

<u>Plant/soil condition</u>	<u>Recommended fertilizer rate</u>
<u>Nitrogen (N)</u>	
Yellow, short, or low N vines	40-60 lb/A
Normal vines	10-40 lb/A
Rank vines or excessive N	0-20 lb/A (none pre-bloom)
High yielding hybrids	20-60 lb/A
<u>Phosphorus (P)</u>	
Tissue tests normal	supplied in NPK NO MORE than 20 lb/A P recommended (45 lb/A P₂O₅)
Soil and tissue tests low	use NPK with higher P
Soil P normal, tissue P low	2-4 lb/A foliar P (pre-bloom)
P excessive in soil	avoid NPK with high P
<u>Potassium (K)</u>	
Soil and tissue tests normal	supplied in NPK, 40-120 lb/A recommended
Soil and tissue tests low	120 lb/A (use 0-0-50 for high K rates)
K excess	use no supplements
<u>Calcium (Ca)</u>	
Soil or tissue deficient	20-30 lb/A (actual Ca) as gypsum AVOID LIME
<u>Magnesium (Mg)</u>	
Soil or tissue deficient	10-30 lb/A as 0-0-22-11 or magnesium sulfate (Epsom salts)

ARE YOU IMPLEMENTING PHOSPHORUS REDUCTION? P FERTILIZER REDUCTION CAN RESULT IN SUBSTANTIAL IMPROVEMENTS IN WATER QUALITY.

CALCULATING FERTILIZER N AND P RATES -- IMPORTANT FOR P REDUCTION PLANS**Basic information - How to calculate rates from the N-P-K on the bag**

- Pounds of N = pounds of fertilizer multiplied by the first number as a decimal
 - example: 150 lb 12-24-12 = 18 lb N (150×0.12)
- Pounds of actual P = pounds of fertilizer multiplied by the middle number as decimal multiplied by 0.44 to convert to actual P (the bag number refers to the amount of P_2O_5)
 - example: 175 lb 15-15-15 = 11.55 lb P ($175 \times 0.15 \times 0.44$)
- Pounds of K = pounds of fertilizer multiplied by the last number as a decimal multiplied by 0.83 to convert K_2O to actual K
 - example: 200 pounds of SulPoMag (0-0-22) = 36.5 lb K ($200 \times 0.22 \times 0.83$)

Example #1

Since we fertilize based on nitrogen -- decide how much N you need. Then choose a fertilizer and calculate how much P you will apply.

My bog requires 35 lb N/A; I want to use 12-24-12

To get 35 lb N -- how much 12-24-12?

- divide amount of N needed by percent N (first number as decimal) in fertilizer
 - 35 divided by 0.12 = 291.7 pounds of fertilizer is needed
- to calculate P - multiply pounds of fertilizer by middle number as decimal and then by 0.44 (to convert to actual P)
 - $291.7 \times 0.24 \times 0.44 = 30.8$ pounds of P applied

That's more P than I expected. What if I switch to 15-15-15?

- Figure out how much 15-15-15 to get 35 lb N
 - 35 divided by 0.15 = 233 pounds fertilizer
- Now calculate the P
 - $233 \text{ pounds fertilizer} \times 0.15 \times 0.44 = 15.4$ pounds of P applied

Example #2

I always use 400 lb/A 12-24-12. How much N and P am I applying?

- For N - multiply the pounds of fertilizer by 0.12 (the percent N in 12-24-12)
 - $400 \times 0.12 = 48$ pounds of N
- For actual P - multiply the pounds of fertilizer by 0.24 (the percent P_2O_5 in 12-24-12) and then multiply by 0.44 to convert to actual P
 - $400 \times 0.24 \times 0.44 = 42.2$ pounds of actual P

WOW! That's a lot of P!! Maybe I want to try that 18-8-18 I am hearing about - how much should I use?

- To get 48 pounds of N with 18-8-18, divide 48 by 0.18 to get pounds of fertilizer
 - $48 / 0.18 = 267$ pounds of 18-8-18
- So - how much P is that? Multiply fertilizer by 0.08 to get pounds of P_2O_5 then convert to P by multiplying by 0.44
 - $267 \times 0.08 \times 0.44 = 9.4$ pounds of actual P

FERTILIZER SOURCES FOR CRANBERRY PRODUCTION

Nitrogen (N): Nitrogen is most often added with phosphorus and potassium in NPK fertilizers. To determine rate of N in granular fertilizers, multiply the percent N (first number on the bag as a decimal) by the amount of fertilizer to be used. For liquid formulations, the calculation must include a correction for the weight of the liquid.

For example: 9-18-9 liquid contains
9% N by weight

Multiply 9% by the weight of a gallon (8 lb in this example) to determine the pounds of N in a gallon

Other N fertilizers:

Ammonium sulfate	21-0-0	may also be used to control moss (1.75 lb/100 ft ²)
Monoammonium phosphate	11-49-0	
or diammonium phosphate	18-47-0	found in some NPK fertilizers
Urea	46-0-0	(urea breaks down to form 2 ammonium molecules)
Fish fertilizer	2-4-2	most common - 10 gal provides 2.5 lb N, 2 lb P, 2 lb K
Slow release fertilizers		IBDU, methylene urea, sulfur coats, resin or polymer coats
Organic fertilizers		composted chicken manure, fish fertilizer, feather meal
Other organic N forms		Seaweed and humate compounds have not given a positive response in cranberry research plots. Avoid sludge based products (e.g., Miloganite) as they are high in heavy metals that become very plant-available in acid soils.

Phosphorus (P): While there is evidence that the addition of P fertilizer can increase yield, there is no evidence for response to rates greater than 20 lb/A. Phosphorus is generally added with nitrogen and potassium (NPK) or as super phosphate (0-25-0) or triple super phosphate (0-45-0). Research indicates that foliar P, bone meal, or rock phosphate can supply the P needs of cranberry bogs as well. *To determine pounds of P in 100 pounds of fertilizer, multiply 0.44 by the second number on the fertilizer label. Use no more than 20 lb/A actual P (~45 lb/A P₂O₅) per season if tissue test is normal. See calculations page.*

Potassium (K): Potassium is generally added with nitrogen and phosphorus (NPK) or with magnesium (SulPoMag or similar product), but may be applied as a foliar spray (of little value in research trials) or as potassium sulfate (0-0-50). Muriate of potash (KCl, potassium chloride, 0-0-60) may be less desirable due to the adverse effects of chloride on cranberry vines. To determine pounds of K in 100 pounds of fertilizer, multiply 0.83 by the third number on the fertilizer label.

General information:

- The best available evidence indicates that cranberries respond poorly to nitrate N; the AMMONIUM FORM is recommended, monoammonium phosphate is an excellent source. Light rates of urea are suitable to correct N deficiencies quickly (when the urea is dissolved and used as a foliar feed). Use blended fertilizers with ammonium N and excellent uniformity of particle size or ammoniated materials. Non-uniform blends will sort during application, giving poor results.
- FISH HYDROLYSATE FERTILIZER is available commercially, is useful for organic production, and has been shown to be a suitable substitute for granular, inorganic NPK. It may provide benefits in soil conditioning and reducing movement of nutrients out of the root zone. Fish fertilizer is a good choice where the bog holds water poorly and/or has a history of needing larger than normal fertilizer rates. The nitrogen in fish fertilizer is tied up in organic compounds. As these degrade in the soil, nitrogen is slowly released for use by the cranberry plants. Leaching losses of nitrogen are reduced. Therefore, 20% lower nitrogen rates provided as fish fertilizer should give the same result as a higher nitrogen rate provided in granular, inorganic fertilizer. This has been demonstrated on commercial bogs. Fish is especially useful in the spring and as a replacement for fall fertilizer (see timing for fish-granular NPK program).
- Use of sulfate containing fertilizers (SulPoMag, ammonium sulfate) does not affect soil pH. However, acid is released into the soil as the plants take up ammonium N. Otherwise, to substantially

lower soil pH, elemental sulfur (S) application is used. Soil pH may influence the types of weeds that invade a bog. See the Weed Management section for information on the use of S for weed suppression. Prior to making S applications, seek advice from Extension specialists or consultants. Apply no more than 500 lb/A/season in one or two applications. **Apply elemental S only to well drained soils and test soil pH prior to application.**

Use this table (courtesy of the Wisconsin Cranberry Crop Management Newsletter) to calculate the amount of S needed to lower soil pH based on desired amount of change and soil organic matter content from the soil test. This is a SLOW process depending on bacterial activity in the soil - pH change will occur over a period of months. Change will be fastest when soil is warm.

Desired pH change	Soil organic matter content (%)					
	0.5-2.0	2-4	4-6	6-8	8-10	>10
	----- Amount of sulfur needed (lb/A) -----					
0.25 units	250	750	1200	1700	2300	2800
0.5 units	500	1500	2500	3500	4600	5500
1 unit	1000	3000	5000	7000	9200	11000

- CALIBRATION AND EVEN APPLICATION of granular materials becomes more difficult when the amount of material applied falls below 75-100 lb/A. When you plan to apply low N rates, a higher rate of a low assay fertilizer may be a better choice than a low rate of a more concentrated material. Example: 100 lb/A 5-5-20 compared to 42 lb/A 12-24-12 to apply 5 lb N/A. However, be careful in your choices as many low N fertilizers are high in P. See Major Elements section.

MINOR ELEMENTS

- Minor element deficiencies are rare in cranberries due to low requirements and high availability on acid soils. Deficiencies may be brought on by soil mineral imbalances or stress conditions (drought, waterlogging).
- When deficiencies are suspected (visual symptoms), confirm with tissue testing. Once confirmed, deficiencies are best corrected with foliar sprays. Such sprays are applied between bud break and hook stage.
- CALCIUM-BORON (5% Ca, 0.5% B, no other minor elements) sprays were the only minor element supplements to give increased crops in our research on non-deficient bogs. Response was greatest on bogs yielding at or below State average crops. We found that 2 applications of 2 qt/A improved fruit set.

TIMING: 10% bloom, mid-bloom. The second application seems most effective. Application by aircraft is more effective than sprinkler application. This is a foliar feed - apply accordingly.

CAUTIONS : 1. Manganese-containing fertilizers or fungicides (Maneb or Mancozeb) may cancel beneficial effect of CaB if applied with or around the same time as CaB.
2. DO NOT use when leaf analysis is above 75 ppm B.
3. If B levels are elevated, but below 75 ppm, eliminate the FIRST application.

APPLYING FERTILIZER TO CRANBERRY BOGS

- SPRINKLER SYSTEMS may be used to apply liquids, flowables, and foliar feeds. Make sure not to mix incompatible materials (jar test first). When using sprinkler systems to apply fertilizer - make sure that coverage is ADEQUATE AND UNIFORM. EVERY EFFORT SHOULD BE MADE TO PRESERVE WATER QUALITY - avoid application of fertilizer to water in ditches and canals.
- Foliar feeds should not be washed off the leaves. Liquid fertilizers should be washed onto the soil. Be sure that you know which you are applying.
- FISH FERTILIZER is a liquid fertilizer. It should be washed in.
- Make sure ground application equipment is properly calibrated.

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TIMING - WHEN TO APPLY FERTILIZERS TO CRANBERRIES

NPK fertilizer may be added in several forms (see previous section). The form chosen will determine the time schedule for applications. Information presented below is for sample programs based on various NPK forms. Plan nitrogen fertilizer applications based on soil type and soil temperature. On sandy soils (<1% organic matter), nitrogen fertilizer may be applied throughout the season. On more organic cranberry soils and older beds, applications should be based on soil temperatures. For typical cranberry bogs (1-4% organic matter), applications of N should not be necessary early in the spring. From flood removal until soil temperatures exceed 55°F, adequate N should be available through biological processes (mineralization). Nitrogen is slowly released from the soil early in the spring when the cranberry plants are dormant. This leads to a 'flush' of ammonium availability when the plants are breaking dormancy. As soil temperatures increase from 55°F to 70°F, release of N through mineralization is only moderate. Fertilizer applications should be beneficial. This corresponds to the period from roughneck stage through bloom. During spells of hot weather, when soil temperatures exceed 70°F and air temperatures exceed 85°F, soil N release increases and crop development slows, so planned fertilizer N applications should be reduced, delayed, or eliminated.

It is best to time fertilizer applications by the growth stage of the plants. This is especially true when weather has been unusual and plant development is off-schedule. For a cold spring, delay soil amendment applications. Fertilizer applications will be less effective if soil temperature is below 50°F because roots will not effectively take up nutrients in cold soil. Dates listed are only approximate, based on an average weather year. See Major Elements section for information regarding rates.

Abbreviation:	Stage:	Timing (avg. weather year):
ES	Early spring	mid-April to mid-May
BB	Bud break	mid-May
RN	Roughneck (1" new growth)	late May
HK	Hook	early June
E-BL	Early (10%) bloom	2nd week June
BL	Mid-bloom	late June
ST	Fruit set (pea size)	2-3 wks. after BL
BD	Bud development	early August
EF	Early fall	late August to September
PH	Post harvest	mid-October through November

Programs					
Stage	NPK granular	Slow release NPK	Slow/fast NPK	NPK granular/Fish	Fish (2 alternatives)
BB		100% total N		10-20 gal/A (fish)	50% 25%
RN	20-25% total N		40% total N		
HK					25%
BL	25-30% total N		60% total N	30-35% total N (gran.)	
ST	25-30% total N			30-35% total N (gran.)	50% 25%
BD	20-25% total N				
EF				10-20 gal/A (fish)	25%

Optional for any program		
ES	Soil amendments	Correct K, Ca, Mg deficiencies
	Soil conditioners	0-0-22-11 or similar at 100-300 lb/A (100-150 recommended)
BB to HK	Minor element supplements	Foliar sprays for deficiencies only
E-BL and BL	CaB	2 qt/A
EF	Fish as fall fertilizer	5-10 gal/A
PH	Fall fertilizer	no more than 5 lb N/A; high K materials best if any used
		AVOID high P materials – minimize P in formulation

IMPORTANT CONSIDERATIONS FOR CRANBERRY NUTRITION

- **CAREFULLY EXAMINE** your P fertilizer use. A reduction plan is highly recommended. Use no more than 20 lb/A of actual P (45 lb/A P_2O_5).
- **REVIEW** the Nutrient Management BMP in the Best Management Practices Guide for Massachusetts Cranberry Production available from the Cranberry Station and on our website. Excellent information and decision trees for planning N and P management are available as well: http://scholarworks.umass.edu/cranberry_factsheets/ (select Nitrogen or Phosphorus for Bearing Cranberries articles).
- **GOOD DRAINAGE AND ADEQUATE IRRIGATION** are essential for best response to fertilizer. Monitor and maintain adequate soil moisture. Small, frequent irrigations may not be adequate to provide moisture to the root zone. For further information, refer to the Irrigation section and BMP.
- **KEEP GOOD RECORDS.** Comparison of rate/material and crop response over time will help to refine fertilizer practices tailored to YOUR bog. **OBSERVE YOUR BOGS OFTEN** -- fertilizer timing depends on growth stage/plant development. Rate can be refined as plants respond during the growing season.
- **SANDY BOGS CANNOT HOLD NUTRIENTS WELL** - apply lower fertilizer rates more frequently. Slow-release fertilizers are also recommended for bogs planted on mineral soils.
- Cranberry bog soil has little capacity to **HOLD** cations (e.g., K, Mg, Ca). Much of the holding capacity is taken up by hydrogen ions. It is important to maintain a **BALANCE** among cations. Overuse of one can induce deficiency of the others. When you test bog soil for pH, check this balance as well.
- **WHEN SYMPTOMS OCCUR**- rule out water management issues, disease, and pest problems first. Then look at nutrition. Collect tissue for testing if necessary.

CAUTIONS:

- **PRESERVE SURFACE WATER QUALITY** - avoid applying fertilizer to water in ditches and canals. As possible, lower water levels in ditches prior to fertilizer application and impound water during and after fertilizer applications.
- **AVOID LARGE RATES APPLIED AT ONE TIME**, particularly on bogs constructed on mineral soils or very sandy bogs. Such applications may lead to lateral movement of fertilizer into water.
- **EXCESSIVE NITROGEN FERTILIZATION** leads to overvegetative plants. This may increase susceptibility to disease, spring frost or insect feeding. High nitrogen rates are associated with poor fruit quality and may delay color development in the fruit. High nitrogen rates can have adverse carry-over effects in following years -- excess applied nitrogen leads to high nitrogen concentrations in plant tissues such as stems and roots that can be remobilized in the plant and lead to excess vegetation, particularly when more nitrogen is added to the soil.
- **FALL FERTILIZER** (after harvest application) is not recommended, particularly if crop was small and no deficiencies have been noted. Late-season applications may not be properly taken up by the plants depending on soil temperature and state of dormancy. Generally, if uptake does not occur in the fall, the nutrients are no longer available the following spring. Organic types of fertilizers may be the exception. If you choose to use fall fertilizer, use low N and low or no P formulations.

EFFECTS OF WEATHER

- **WINTER INJURY.** If leaf drop occurs after withdrawal of winter flood, early spring fertilizer applications will aid in recovery by encouraging rapid, early production of new leaves. Do not skip spring fertilizer. SulPoMag (or similar material) at 100-200 lb/A may also aid recovery.

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- COLD SOIL/AIR TEMPERATURES, particularly in the spring, will lessen or eliminate response of cranberry plants to fertilizer applications. If plants are already under stress, they may respond even less. If this occurs, care should be taken not to reapply before you are sure that the plants are not going to respond to the initial application. Soil temperatures should rise to 55°F before application of fertilizer to ensure response. If long-lasting, slow-release, or organic forms were used, reapplication may not be necessary -- response may only be delayed.
- IF FLOWER BUDS ARE DAMAGED BY SPRING FROST, high N rates can lead to overgrowth. Use lower rates.

EFFECTS OF PESTS AND CULTURAL PRACTICES

- Decreasing pre-bloom N may impact TIPWORM populations by limiting lush growth for insect feeding.
- BOGS CONSTRUCTED ON MINERAL SOILS without a permeability restricting or confining layer have little ability to hold nutrients in the root zone. Use organic or slow-release N and avoid large rates applied all at once.
- DECREASE fertilizer rate if the bog has been SANDED. Sanding promotes production of new vegetative uprights from the runners. Sanding combined with high fertilizer rates can lead to overgrowth.
- DECREASE fertilizer rate if LATE WATER has been held. Spring fertilizer rate may be eliminated on late water bogs. Overall fertilizer rate may be decreased 30% or more. However, do not decrease fertilizer N by more than 40% at the risk of adverse impact on the following season crop.
- ELIMINATE fertilizer applications for the entire season if the bog has been subjected to a long SUMMER FLOOD (May-July, see Insect section) for grub control.
- If eliminating crop using a FLASH FLOOD, reduce fertilizer rate. A low rate applied in the spring and mid-season should suffice to support the plants.
- PRUNING stimulates growth - reduce spring fertilizer on heavily pruned bogs. However, if the bog has been mowed, fertilizer applications are required to encourage the production of new uprights.

ADDITIONAL INFORMATION REGARDING P FERTILIZER APPLICATIONS:

In this example, the grower applies 45 lb/A N using various fertilizer choices. As you can see, choice then determines P rate. Reduced P materials in this example also reduce the pounds of fertilizer needed to achieve the 45 lb/A N, thus reducing application costs.

Material used	lb/A N applied	lb/A fertilizer used	lb/A P applied
12-24-12	45	375	40
18-8-18	45	250	9
15-15-15	45	300	20

In this example, the grower applies only set fertilizer and chooses to apply 20 lb/A P. The table shows the maximum fertilizer rate that can be used to maintain the chosen P rate and the maximum N that can be supplied without exceeding the chosen P rate. Low P fertilizers allow the applications of high N rates where needed without exceeding the 20 lb/A P recommendation.

Material used	lb/A P applied	max. lb/A fertilizer	max. lb/A N
12-24-12	20	188	22.5
18-8-18	20	568	102
10-12-24	20	379	38
15-10-18	20	454	68
15-15-15	20	300	45
19-19-19	20	235	45

IRRIGATION WATER MANAGEMENT 2012

Prepared by Peter Jeranyama

Water management is arguably one of the most critical issues affecting the cranberry industry for four major reasons: (a) crop production, (b) environmental concerns, (c) costs and (d) regulatory scrutiny. The objective of this section is to (i) introduce the concept of crop water stress index (CWSI), and (ii) discuss soil moisture monitoring devices such as tensiometers, moisture sensors and water level floats.

An evaporative demand study conducted by Bruce Lampinen showed that for many weeks during the growing season, most cranberry beds were too wet. Wet conditions as a result of inadequate drainage or excessive irrigation in cranberry production could potentially result in increased root rot and fruit rot diseases, inhibition of root development, reduced fruit retention and reduced productivity. Traditionally, cranberry beds received one inch of water per week from either rain, capillary action from the groundwater, irrigation or some combination of these. But conditions can vary from bog to bog so the **one inch (1") rule** does not always result in ideal soil moisture conditions. In general the following bog conditions exist in MA (i) new renovations and constructions (0-10 years old) those with a constructed sub-grade, (ii) renovated beds that have a peat/hardpan natural underlayment, and (iii) older beds that after sanding have developed a layered soil in the root zone, alternating sand and layers with root mass (organic layers). The layering structure of these older bogs will present challenges to getting uniform contact with monitoring devices.

Plants maintain hydration and internal temperature through a process called transpiration in which water is moved from the soil, through the roots and shoots and out through pores (stomata) in the leaves. As this process occurs, moisture is depleted from the soil. The plant can control the rate of transpiration by controlling the opening of the leaf stomata to let the water out. However, there is evidence that cranberry has poor control over its stomata and therefore, its transpiration process. In other crops, crop water stress index (CWSI) is used to measure plant transpiration from canopy temperature and air dryness. Because of the poor control of transpiration in cranberry, we as yet have no such index specific to cranberry. And since there is evidence that cranberry has poor control over its transpiration process, leaf measurements alone may not sufficiently define CWSI for cranberry. There is a need to use a cafeteria approach, that includes plant processes but also looks at the soil-water matrix to quantify water stress at different soil water conditions. This can then be used as the basis for irrigation scheduling over a wide variety of cranberry bogs. At present, our recommendations for irrigation management are based on soil water conditions only.

Measurement of soil water status is based on two technologies: (i) measuring the amount of water in the soil (e.g. 'feel test', water float, or volumetric water sensor) and (ii) measuring the energy status (water potential) of the water (e.g. tensiometer).

Appearance and Feel Method. Although measuring soil water by appearance and feel is not precise, with experience and judgment, you should be able to estimate the moisture level with a reasonable degree of accuracy. **However, this can be very challenging in sandy soils and is not a recommended method.**

Soil probing can be used as a check on other monitoring methods and is especially useful in monitoring the depth of penetration of irrigation applications and rainfalls. Sometimes other problems, like compacted soil layers, can be detected from the probing.

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The following guideline is usually used on coarse textured soils, sandy loams and loamy sands. If soil in the hand is (i) dry, loose, flows through fingers - 0 to 25% available moisture, (ii) looks dry, will not form ball with pressure - 25 to 50% available moisture, (iii) will form a loose ball under pressure, will not hold together even with easy handling - 50 to 75% available moisture, and (iv) forms weak ball, breaks easily, will not 'slick' - 75 to 100% available moisture.

Water Level Floats. In cranberry, water level floats have been used to determine when to irrigate, but they only measure the level of the water table and do not include any plant processes or plant evaporative demand. And yet, it is the plants that in large part control the use of the soil water, thus depleting it and triggering the need for irrigation. Water level floats have the advantage that you can see the level of the water table without walking onto the bog. Instructions for constructing a water level float are available from UMass Cranberry Station website at: <http://www.umass.edu/cranberry/pubs/factsheets.html>.

Water demand by vines can be assessed by comparing the water level in the center of the bed to the water level in ditches to see if water is moving fast enough across the bed. By observing the water level float through several irrigation cycles, you can determine the number of hours required for an adequate irrigation.

Tensiometers. A tensiometer is a sealed, water-filled tube with a vacuum gauge on the upper end and a porous ceramic tip on the lower end. A tensiometer measures the soil water potential in the soil. As the soil around the tensiometer dries out, water is drawn from the tube through the ceramic tip. This creates a vacuum in the tube that can be read on the vacuum gauge. When the soil water is increased, through rainfall or irrigation, water enters the tube through the porous tip, lowering the gauge reading.

Tensiometers provide a valuable measure of the energy status of water in the soil, thus providing a rigorous indication of the water availability to plants, with values that allow comparisons between a set of growing conditions.

A tensiometer reading in the **2 to 5 cbar** range should be expected as long as the water table is between 8 and 18 inches. This range is adequate for cranberries (see Table on next page).

Volumetric Water Content. Soil water content indicates how much water is present in the soil. It can be used to estimate the amount of stored water in a profile or how much irrigation is required to reach a desired amount of water. Soil volumetric water content sensors provide a tool to measure the water content of the soil. Installing these sensors into the soil allow you to collect long-term measurements.

Based on our current research, cranberry bed soil appears to be saturated when volumetric water content is 30 to 40%. At this water content the free air spaces are filled with water. Irrigation should be stopped before saturation to promote water and solute uptake by the plant. On the other hand, field capacity occurs at around 10% volumetric water content. Field capacity is the water content after a saturated soil has been drained of all free water. This corresponds to when you should to start to irrigate.

Volumetric water content measurements are simple, reliable and inexpensive.

Recommendations:

A general problem with estimation of soil moisture arises because of the heterogeneity within soils, with single point measurements rarely being representative. Ideally, several devices should be distributed across the management area covered by an irrigation system.

We have shown through research that zone of saturation, when all air pores are filled with water, was reached between 30% and 40% volumetric water content depending on the soil subsurface. This volumetric water content corresponds to a tension of 1 and 2 cbar (or kPa). Field capacity is reached when the soil has drained all its free water and at this stage the soil is ready for irrigation. In our research, field capacity was reached between 5% and 15% which corresponds to a tension of 4 and 5 kPa. In simplicity, irrigation should be initiated when a tension of 4.5 kPa (at field capacity) has been reached and stopped when a tension of 2kPa (before saturation) has been achieved. Using a volumetric water sensor, irrigation should be started when a water content of 10% is recorded and stopped before 30% moisture content.

Table. Critical levels of tension, volumetric water content and water table level for irrigation scheduling on cranberry beds. Use these as a guide for when to irrigate.

	Morning tension	Midday tension	Volumetric water content	Water table level
	-----cbars-----		%	inches below surface
Too wet	0 to 2	0 to 2	>30	0 to 6
Adequate	>2 to 5	>2 to 10	15 to 29	>6 to 18
Too dry	>5 to 80	>10 to 80	<12	>18

LATE WATER AND CRANBERRY MANAGEMENT 2012

Prepared by C.J. DeMoranville, A.L. Averill, F.L. Caruso, and H.A. Sandler

Late Water (LW) is a 30-day spring reflood applied several weeks after the winter flood has been removed and before the plants have lost dormancy (not yet fully green). LW suppresses some insects and Southern red mite (SRM). Fruit rot disease is reduced on LW bogs and keeping quality is improved. LW has also been shown to suppress growth of dewberries (brambles).

Significant reductions in pesticide inputs may be achieved with the use of late water.

FLOOD MANAGEMENT

When to use LW: Late water should be used no more than one year in three. If the previous summer was very sunny and none of the adverse weather conditions listed below are present, the use of LW should be considered for its benefits in insect, mite, disease, and weed control (see below).

When not to use LW: To minimize crop reduction, late water should not be used more often than once every three years. Bogs with poor quality water supplies may not be good candidates for late water. Do not use LW if the winter has been unusually cold or abnormally warm (particularly if the fall was also warm). ***Do not use LW in the spring following a fall flood.*** Inspect the bog after withdrawing the winter flood - if stress, winterkill or leaf-drop are apparent, do not use LW. Do not use LW if the bog was sanded the previous fall or winter. However, barge sanding in the LW flood has been successful. Experience has shown that in some years (on average, 1 in 10 years) late water bogs may produce significantly (>10%) lowered yields. Overall, however, this low yield may be offset by higher yields in subsequent years. Costs in the LW year should also be less, particularly if inputs are reduced due to reduced pest pressure, helping to offset any losses. It is not known exactly what factors contribute to these occasional lower yields, but avoiding LW in the conditions listed above should provide some insurance against a large crop loss.

When to apply the flood: The flood should be applied in the spring prior to the breaking of bud dormancy. The leaves will be beginning to lose their dormant red color but the flower buds should still be red and tight. Generally, the 30-day LW flood will be applied between April 15th and 20th. If temperatures in late March - early April are warm (5°F per day above normal) or the season is early due to warm winter temperatures, the flood may be applied earlier (up to one week). Do not apply the flood if the buds have broken dormancy. We recommend putting sprinkler heads in place prior to the flood. This allows easy application of algaecide if needed (see below) and ensures that you will be ready if a frost night occurs immediately after flood removal.

Depth and temperature: The flood depth should be maintained so that all vines are well covered by water. Shallow floods and/or flood temperatures consistently greater than 65°F should be avoided to prevent injury and crop reduction. Flood water temperatures will generally be cooler if the flood is deep (> 12 inches above the vines). Beds that are severely out of grade may be poor candidates for LW.

Prevention and treatment of scum: Algae (scum) often forms in LW floods. Water temperature is a major factor in the development of scum; shallow floods and inland, warmer locations may be more prone to this problem. If your flood is shallow or if you have had scum problems in LW or winter floods, plan to treat using a liquid copper algaecide applied two weeks into the flood period (Algae-Pro, Cutrine Plus, etc; see the Weed section for more information). The material is injected into the sprinkler system running at 20 psi (30 minute injection, you may continue running for 1-2 hours after to disperse the material). Rates are calculated using label information and the number of acre-feet to be treated. To calculate acre-feet, multiply the number of acres by the depth of the flood in feet (take into account variation due to non-uniform flood depth). If you do not use this treatment, you must scout shore ditch edges for the presence of algae and treat with copper compounds as soon as scum is observed. Remember that copper only prevents further algal growth (it doesn't eliminate existing scum), so prompt treatment is necessary. If scum is severe, early withdrawal of the flood may be necessary. If heavy scum is present after the flood, it should be broken up mechanically so that light can reach the vines. Even so, crop reduction may occur when scum is severe.

<u>Late Water Flood Timing</u>		
Location	Apply the flood around:	Remove the flood:
Inland Areas	April 10-15	no later than May 15th
Coastal Plymouth County	April 15-20	about May 20th
Cape Cod	April 20 or later	late May
<i>Choose actual application timing based on weather (see previous page) and hold for approximately 30 days.</i>		

Draining: Release the flood slowly over the top board to protect water resources. The date of flood removal will vary with location and date of application. If air temperatures are unseasonably warm, and flood water temperature becomes too high, the LW flood may need to be removed prior to 30 days. If the flood is removed early, pest management benefits may be affected (see insect management next page).

MANAGEMENT AFTER LATE WATER:

Irrigation: There should be no need to irrigate (unless protecting for frost) for at least 2 weeks after the LW flood is withdrawn. Always schedule irrigation based on soil moisture status.

Frost protection: After removal of the LW flood, cranberry buds are sensitive to frost injury. During LW, the appearance of the terminal bud is arrested at the spring dormant stage. However, internal changes in the bud lead to a loss of frost tolerance despite appearances.

When using LW, frost management should be based on the actual duration of the flood, rather than the appearance of the buds. After more than one week of flooding, appearance of the buds will not be an accurate predictor of tolerance. A one-week flood early in the spring has no impact on frost tolerance -- protect the buds based on appearance. After LW of longer than 1 week, protect the bogs for 27°F (flood duration = 2 weeks) or 30°F (any duration longer than 2 weeks).

Fertilizer use: LW bogs respond readily to fertilizer: N dose should be reduced to avoid overgrowth. A 30-40% reduction of N is possible by eliminating the spring application and/or reducing the fruit set dose. Further reductions may have impact on bud development for the following year. Remember, fertilizer applied in the current season has the greatest impact on the *following* season's crop. The best tactic for a LW bog is to add no fertilizer for at least 2 weeks after flood withdrawal and then add small amounts with close monitoring of response. Generally, no fertilizer should be needed until bloom. Time your applications by the plant's development. This is especially important when development has been shifted in time by the use of LW. If the LW flood was terminated early (duration of 3 weeks or less), standard fertilizer regimens may be followed.

Disease management: Late water is an excellent cultural control strategy against fruit rot.

Processed fruit and fresh fruit Howes, year of the LW flood - Use reduced rates and number of applications of fungicides. Fungicides may be eliminated on processed-fruit beds if keeping quality is forecast to be good. If one application is to be made, apply at 50% bloom. If two fungicide applications are made, apply the first at 10% bloom and the second two weeks later. *Reduced fungicide rates should be employed*, especially for Howes, which has greater resistance to rot. Experience with Stevens in LW is limited, but generally it has even better rot resistance than Howes.

First year after LW has been held - Fungicide applications and rates can still be reduced without sacrifice in fruit quality.

Second year after LW has been held - Fungicide applications and rates should be increased to a normal schedule. Otherwise, fungal inoculum will increase and may cause significant field and storage rot losses.

New Plantings - Late water held in a newly planted (one or two year-old) bog will help prevent inoculum buildup, as well as helping the vines spread over the surface of the soil. Both of these factors will help reduce the amount of rot during the initial two crop seasons. Late water may also slow down weeds on new bogs (see next page).

60 Late Water

Insect and mite management: Many insects are affected by LW. Emergence is delayed, and when a type of insect does appear, emergence is often synchronous, permitting better management. LW can be used to manage several pest insects:

Early season insects - False armyworm and Gypsy moth may be suppressed. In general, cutworms have not been a problem in recent years on LW bogs. Pre-bloom sprays are seldom needed, but sweep net **scouting** should still be carried out -- cutworm moths may be attracted to the wet bog just after flood removal as a site for egg laying. If this happens, infestation may be quite severe. In addition, spanworms have sometimes been found on LW bogs.

Cranberry fruitworm - Cranberry fruitworms, that overwinter in the bog in hibernacula (cocoons), have been shown to be greatly reduced by LW. Mortality is higher when the flood is warm (approx. 60°F). Shorter duration (2.5-3 weeks) LW floods appear to have little effect on mortality in the hibernacula; populations are suppressed very little, compared to those on unflooded beds and significantly less than those on beds receiving a 4-week flood (see table below). Monitoring for infestation is important (see the insect section for scouting practice after LW). Fruitworm sprays may be eliminated on LW bogs. Second and third sprays are seldom needed but scouting for eggs should continue as populations may move in from surrounding beds.

Effect of late water duration on cranberry fruitworm mortality. Data based on failure of insect to emerge from hibernacula following flood.

Site	Flood length	CFW mortality	
		flooded	no flood
1	2.5 weeks	50%	28%
2	2.5 weeks	45%	13%
3	2.5 weeks	40%	34%
	4 weeks	98%	20%
4	3 weeks	41%	37%
	4 weeks	94%	71%

Sparganothis fruitworm is not controlled by LW. Flight is synchronized making management easier.

Southern red mite - Mites can be severely impacted by holding late water. Intense infestations can be essentially eliminated in the year of late water. The mites begin to increase in the second year following the flood, but even then, may stay much below the original infestation level prior to the flood. Generally, LW affords two years of control for this pest.

Weed management: While LW may delay weed development and suppress the growth of some perennial weeds, this technique alone does not result in *control* of most established weeds. LW does not control dodder.

Dewberries (running bramble) - Some success in retarding the growth of dewberries by holding late water has been shown. Sawbrier (*Smilax glauca*) was less affected. LW suppression of dewberries should be followed up with other controls such as hand-wiping, clipping, or perhaps flame cultivation with glyphosate. Fall flooding also suppresses dewberries. However, severe crop loss resulted when LW was used in the spring following a fall flood. Do NOT combine these practices.

Herbicide use:

- Do not apply preemergence herbicides prior to a late water flood.
- Low rates of Casoron (up to 40 lb/A) may be applied *after* the late water flood is withdrawn for the control of **dodder**. Apply herbicide as soon as possible after the withdrawal of the flood (be sure the vines are dry and the soil has drained).
- No other preemergence herbicides should be applied after the flood is withdrawn.

Bees: Bees for pollination may be more important on late water bogs due to the fact that the period of flowering is of shorter duration than that for early water bogs. Protect bees from pesticide exposure.

WINTER MANAGEMENT 2012

Prepared by Carolyn J. DeMoranville

Cranberry vines may be injured or killed by severe winter weather. The most common injury is classified as a 'physiological drought' when moisture lost from the vines due to wind and evaporation cannot be replaced due to freezing in the root zone. The common term used to describe that injury is 'winterkill'. The symptoms are leaf discoloration and eventual leaf drop. Such injury can occur within 3 days if the root zone is frozen to a depth of 4 inches, air temperature is below freezing, and strong drying winds (10 mph or greater) occur. Injury is prevented by protecting vines with a winter flood that should be in place when winterkill conditions exist. It is thought that 2-3 days with temperatures below 20°F will be enough to freeze the soil. Bogs that have not been harvested and new plantings (first year) are less susceptible to winterkill but should still be protected in severe conditions.

General winter flood management:

The winter flood may be applied as early as December 1 and should remain on the bog as long as winterkill conditions are present or forecast. The flood may be delayed as long as winterkill conditions are not forecast as long as the plants are fully dormant. Exposure to moderately cold temperatures will encourage deeper dormancy leading to lower oxygen and carbohydrate demand and greater cold tolerance. However, an early cold snap following a warm fall could lead to actual cold injury in the plants (similar to frost injury). Under such conditions, the winter flood should be in place even before winterkill conditions are reached. Generally, the flood should not need to be held any later than March 15. However, holding the flood for a few days past that date will not harm the bog.

To be effective, the flood should cover the plants entirely (no vine tips sticking out). It is particularly important to maintain a sufficiently deep flood on new plantings to prevent heaving of the plants during freeze/thaw cycles during the winter.

For bogs that cannot maintain a winter flood:

On bogs that cannot maintain a winter flood, additional winter protection may be gained by the application of an antitranspirant. These waxy or resin-based materials reduce the amount of water loss from the leaves by providing an additional physical layer on the leaf surface. Research with Vapor Gard has shown that one application, made prior to the onset of winterkill conditions, may offer some protection against winter injury. Vapor Gard should be applied at the rate of 1 gal/A. Since the material becomes quite thick at low temperatures, application is best when done at temperatures above 45°F (above 50°F is much preferable). It may be combined with hot water to facilitate mixing. It can be applied through the irrigation system, by boom sprayer or tank spray apparatus. Vapor Gard needs at least one hour of sunny conditions after application to ensure proper set of the material on the leaf surface. Vapor Gard will persist on the plant for several months, so application should be planned for the fall (November typically has favorable conditions). Other products such as Wilt-Pruf or Moisturin are available, but we do not have much experience with these.

Oxygen deficiency injury:

Historic research by Bergman, indicated that a lack of dissolved oxygen in the winter flood water was the cause of injury to cranberry plants, resulting in leaf drop and reduced yield potential. Plants, like animals, use oxygen in respiration so lack of oxygen could lead to plant injury. Bergman stated that oxygen deficiency injury may occur when oxygen levels in the winter flood water drop below 4 mg/l (full oxygenation = 10+ mg/l). Bergman further stated that lack of light penetration led to poor photosynthesis and it was the lack of photosynthesis that led to poor oxygenation in the water. The recommended remedy was to remove water from under the iced-over flood if light penetration was poor.

Removal of water from beneath the ice is standard practice in WI and in cold conditions in MA. In WI, the removal of remaining water is done as soon as a thick ice layer forms on the surface. Air then penetrates along edges and through cracks in the ice so that the vines are exposed to atmospheric oxygen. If the flood remains unfrozen as is often the case in MA and NJ, oxygen readily mixes into the water from the surrounding air.

62 Winter Management

Recent research in both MA and WI has caused us to re-examine Bergman's theories and recommendations. Research by Justine Vanden Heuvel and Teryl Roper showed that cranberries require very little light for photosynthesis and the light that penetrates snow or sand may be sufficient for this purpose. Further, in a bog with a full layer of water beneath ice, even with 9 inches of snow on the ice, oxygen in the water beneath remained at 8 mg/l or greater. In WI, covering ice with black cloth, sand, or snow did not lead to leaf drop or crop reduction in the plants below the treatments. In MA, plants held flooded in darkness and low oxygen did not show reduced carbohydrate (the product of photosynthesis) or leaf drop.

So what is the cause of the leaf drop that is observed after the winter at certain bogs? Definitely, loss of leaves is a sign of some sort of stress on the plants. It is unlikely that lack of light is the cause. Lack of oxygen remains a possibility if the levels actually become severely depleted. A likely scenario for this would be pulling the water from beneath the ice and leaving a shallow layer of water in low spots. The smaller volume of water could become oxygen depleted where a large volume had not.

As wetland plants, cranberries can survive periods of poor oxygenation during flooded conditions. In particular the plants can tolerate low oxygen levels in saturated soil. However, survival under these conditions requires using up carbohydrate (food) reserves. Plants with poor carbohydrate reserves due to large crops, poor sunshine the previous fall, or other stresses may have less ability to tolerate low oxygen stress and may show injury the next spring. In those cases, failure to prevent oxygen deficiency can result in leaf drop, inability of blossoms to set fruit, and crop reduction.

Certainly, any risk associated with using a winter flood is far outweighed by the benefit of protection from winterkill injury.

To assure that leaf drop potential is minimized:

- Remove the water from beneath a frozen flood as soon as is practical – this also minimizes mobilization of soil phosphorus into the flood water due to soil anoxia.
- If water is being held beneath ice in order to expedite sanding, monitor oxygen levels in the underlying flood. Do not allow water with <3 mg/l oxygen to remain beneath the ice. Consider acting at a reading of 5 (mg/l) on a standard color kit.
- Try to avoid shallow layers of water beneath ice, they may lose oxygen more readily than deeper layers of water.
- If you pull the water from beneath ice -- make sure that you leave no puddles behind. Vines trapped in these puddles under the ice are particularly susceptible to leaf drop in the spring.
- Manage plantings during the season so that stress is minimized -- in particular, irrigate properly.

Management after a mid-winter thaw:

Once the water has been removed from beneath the ice, the remaining ice may melt during a mid-winter thaw, leaving the vines exposed. Bogs may be left exposed as long as winterkill conditions are not present (see above). However, long exposures to abnormally warm temperatures (>55°F) may lead to loss of chilling. The result could be a reduction in hardiness and greater susceptibility to spring frost. Depending on the conditions prior to the winter flood, loss of chilling during a mid-winter thaw could also lead to reduction in bud break and flowering the following season. This is especially true if the previous fall was warmer than usual, leading to lack of chilling accumulation. To guard against these possibilities, reflood the bog if a long warm spell is forecast during mid-winter. The water will cool at night and re-warm slowly during the day, buffering against the warm daytime temperatures.

Management after the winter flood:

Once the flood has been removed, the cranberry buds will break dormancy in response to exposure to warm temperatures. The earlier the flood is removed, the sooner the plants will experience enough heat units to break dormancy. To avoid the need for frost protection during the first half of April, hold the winter flood until March 10-15. In the early spring, cranberry buds will survive exposure to at least 18°F. As the buds lose their dormant color and begin to expand, they must be protected from frost damage. The tolerance varies by variety and growth stage. Refer to the "Frost protection guide for Massachusetts cranberry production", the Frost Management BMP, and frost alerts on the Station's webpage for further information: <http://www.umass.edu/cranberry/index.html>.

GROUNDWATER PROTECTION REGULATIONS AND ZONE II IN 2012

Prepared by Martha M. Sylvia

The Massachusetts Department of Agricultural Resources (MDAR) is charged with maintaining clean groundwater. To this end, they have issued Groundwater Protection Regulations. These Regulations are intended to prevent contamination of public drinking water supply wells through regulating the application of pesticide products on the Groundwater Protection List within primary recharge areas. A primary recharge area is either an "Interim Wellhead Protection Area (IWPA)" or a "Zone II". In this publication, we refer to all primary recharge areas including IWPAs as Zone IIs. The Zone IIs are updated yearly. The pesticide groundwater protection regulations ONLY apply to public drinking water wells that pump greater than 100,000 gallons of water per day (gpd).

Some products registered for use on cranberry (listed below) have the potential to leach through the soil and as a result have been placed on the Groundwater Protection List. If you are in a Zone II, you should review the particulars for each compound to determine if you can use it in your situation. If you are able to use a compound, you must follow these rules:

- ❖ **MDAR notification** within 10 days of the end of the month for each application. You may use one form to report multiple applications that occurred in the same month. Forms are available at the Cranberry Station, CCCGA, points of purchase, or online:
<http://www.mass.gov/agr/pesticides/water/cranberry.htm> (click on cranberry notification form)
<http://www.cranberries.org/growers/alerts.html> (click on Zone II)
- This reporting form must be filed in addition to the Pesticide Applicator Form that reports annual use to the state.
- ❖ Confirmation of 50% foliar cover. Assume an established working bog has at least 50% foliar cover but a new planting likely does not.
- ❖ An approved IPM program (use of Cranberry Chart Book) and an acreage-specific IPM plan.
- ❖ A support letter from UMass Extension and/or a copy of this chart book showing you have confirmed that your conditions allow the application.
- ❖ Proper documentation showing failure of alternatives. Generally, IPM records will suffice.

Cranberry Compounds on the Groundwater Protection List

chlorothalonil	Bravo Echo, Equus Chloronil Chlorothalonil	While these compounds are listed on the groundwater protection list, you may still use them within a Zone II area if you meet the conditions (outlined on p. 65) for each one and there are no viable alternatives.
methoxyfenozide	Intrepid	There are alternatives available (Confirm, SpinTor, and Delegate) and this product cannot be used in Zone II areas. In very special cases permission may be given during bloom for management of black-headed fireworm infestations. Contact Cranberry Station.
thiamethoxam	Actara	There are alternatives available (Avaunt spring, Belay summer) and should be used in Zone II areas. However, if your handler has restricted Belay use, then you may use Actara in summer for the second generation weevil in Zone II areas (complete paperwork).

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Guidelines provided by Massachusetts Department of Agricultural Resources (MDAR):

Greater detail is provided at the MDAR website (<http://www.mass.gov/agr/pesticides/water/index.htm>) or from the Cape Cod Cranberry Growers' Association (at their website, <http://www.cranberries.org/> under Grower services, then Grower advisories, then Groundwater protection).

Are you applying a product that is listed on the Groundwater Protection List within a regulated primary recharge area?

The pesticide groundwater protection regulations ONLY apply to public drinking water wells that pump greater than 100,000 gallons of water per day (gpd). The primary recharge area is designated as a Zone II or an Interim Wellhead Protection Area (IWPA) by the Massachusetts Department of Environmental Protection (DEP). Listed below are several ways to establish if you are in a regulated primary recharge area.

Determining The Location of a Regulated Primary Recharge Area - Zone II or IWPA.

To determine if the application site falls within a Zone II or IWPA, you can use the following options:

Bound Map Books

You should check the updated bound map books available at your local Ag dealers, the Cranberry Station, or the CCCGA. These books are provided by the Cape Cod Cranberry Growers' Association. The maps are organized alphabetically by town. Main roads, waterways, Zone IIs and cranberry bogs are easy to identify on the maps.

Internet Option

If you have access to the internet, you can go to the MDAR website (<http://www.mass.gov/agr>). Click on "Pesticide Programs", then click on "Public Drinking Water Supply Protection". On the left menu, click the link "Zone II Areas Listed by Town" and then the name of your town from the list. A map will open with tools to zoom in on specific areas of the town. The Cape Cod Cranberry Growers' Association also has a set of internet maps accessible at:

http://www.cranberries.org/growers/alerts_zone2.html.

DEP also has a link: <http://maps.massgis.state.ma.us/WSPA/viewer.html>.

Other Options

Check with the regional DEP office, DEP Southeast Regional Office: 508-946-2700.

Are you applying pesticides in an area that has less than a 50% foliar cover?

If your area of application is located within the primary recharge area, you must determine if you are applying to an area with less than or greater than 50% foliar ground cover.

Assume an established, harvestable bog has at least 50% foliar cover.

If your bog is a new planting or it has not vined in to at least 50% foliar cover, and you wish to apply a pesticide listed on the groundwater protection list within a Zone II or IWPA, then the applicator must submit a Pesticide Management Plan (PMP) to MDAR for that use pattern and have it approved prior to the application. If this is the case, contact CCCGA or MDAR to develop this plan.

What is an Integrated Pest Management Program?

Pesticides on the groundwater list must be applied as part of an Integrated Pest Management (IPM) program from an MDAR approved source. These include:

- Use of the current "Cranberry Chart Book" published by the UMass Cranberry Station.
- UMass Extension generated fact sheets that outline IPM practices specific to the pest problem.
- IPM Programs specifically developed to meet the requirements of the Groundwater Protection Regulations.

The Department does not require the submission of IPM plans for approval. Instead the applicator should maintain a copy of their IPM program in their records. The plan should be specific to the pest problem requiring management with the Zone II chemical. The plan information should include:

- The name of the applicator.
- The location (Zone II and property) and dates of the application.
- A problem statement that outlines the reason for using the pesticide product on the Groundwater Protection List.
- An account of the method used by the applicator to identify the problem. Any laboratory diagnosis of the pest problem must also be maintained.
- An account of the IPM measures that have been taken to manage the problem.
- A letter or statement from the appropriate UMass Cranberry Station personnel stating that there is no viable alternative to the use of the product on the Groundwater Protection List to control the particular pest problem.

CONDITIONS TO ALLOW APPLICATION OF COMPOUND

Chlorothalonil - Bravo, Echo, Equus, Chloronil, Chlorothalonil

If your cranberry bog is located in Zone II and you wish to apply a chlorothalonil product, you must consider the following conditions and select the most appropriate scenario that applies to your situation:

- If you have traditionally had good fruit quality (less than 3% rot at delivery), you should use any of the fungicides that do not have chlorothalonil as the active ingredient. It is advisable to keep records of fungicide performance (i.e., level of fruit rot incidence). This will provide evidence and documentation in case you need to use a chlorothalonil fungicide in the future due to the failure of alternatives.
- If you have previously used non-chlorothalonil fungicides on the bed located in the Zone II and you can show that these alternatives performed poorly or failed, you can use the chlorothalonil fungicides because you have no other viable option. You must have some documentation (scouting reports, IPM notes, delivery records with more than 3% rot present) that indicates fruit rot was not controlled with previous non-chlorothalonil fungicide applications.
- If you have previously used non-chlorothalonil fungicides on the bed located in the Zone II and you can NOT show that they did not perform poorly or failed, you must continue to use non-chlorothalonil fungicides. You cannot use chlorothalonil products until and unless you can document that alternatives do not work.
- If there was a significant amount of upright dieback in the bed located in the Zone II during the previous growing season and a pre-bloom application is warranted, Champ can be used instead of a chlorothalonil fungicide for control of this disease. If you do not get adequate disease control using Champ, a chlorothalonil fungicide can be used in the subsequent growing season.

General Information

The chlorothalonil fungicides are considered to be a necessary component of an integrated approach to control fruit rot in cranberry. Many years of field testing in MA have proven that they are the best of the fungicides registered for cranberry fruit rot and upright dieback control. One of their strengths are sticking agents that help to adhere the fungicide tightly to the target tissue, which allows the fungicide to better withstand degradation by sunlight and washoff by rainfall. They are especially important in beds devoted to production of fresh fruit, where excellent fruit quality is desirable, particularly since these berries may be stored for two months. The chlorothalonil fungicides have consistently afforded the best control of storage rot (at eight weeks after harvest) in field trials at State Bog.

66 Conversions and Pesticide Storage

MEASURES AND CONVERSION CHART

Prepared by Hilary A. Sandler

Liquid Measures

1 oz = 2 tablespoons = 6 teaspoons = 29.6 ml
1 cup = 8 oz
1 pint = 2 cups = 16 oz
1 quart = 2 pints = 4 cups = 32 oz
1 gallon = 4 quarts = 8 pints = 16 cups = 128 oz
1 cup = 237 ml
1 pint = 473 ml = 0.473 liters
1 quart = 946 ml = 0.946 liters
1 gallon = 3.78 liters = 3,785 ml
1 acre-foot water = 326,000 gallons
0.1 inch water per acre = 2717 gallons

Mass Conversions

1 oz = 28.4 grams
1 lb = 454 g = 0.454 kg
1 kg = 2.2 lb = 35.2 oz

Temperature Conversions

$^{\circ}\text{F} = (9/5 ^{\circ}\text{C}) + 32$ (guesstimate: double $^{\circ}\text{C}$, add 30)
 $^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$

Length and Area Conversions

1 acre = 43,560 sq. ft = 0.405 hectares
1 hectare = 2.47 acres
1 meter = 1.09 yards = 3.28 feet = 39.4 inches
1 yard = 3 feet = 36 inches = 0.914 meters
1 cm = 0.39 inches
1 inch = 2.54 cm
1 rod = 16.5 ft
1 sq. rod = 272.2 sq. ft
1 square meter = 10.76 square feet
1 cubic meter = 35.29 cubic feet = 1.30 cubic yards
1 inch layer of sand per acre = 134 cubic yards

Other Conversions

pt/A * 0.473 = liters/A
pt/A * 1.167 = liters/ha
lb/A * 0.454 = kg/A
lb/A * 1.12 = kg/ha
gal/A * 3.78 = liter/A
gal/A * 9.33 = liter/ha
ton/A * 2,245 = kg/ha
bbl/A * 0.112 = Mg/ha
 $\text{g/ft}^2 * 0.958 = \text{bbl/A}$

PESTICIDE STORAGE GUIDELINES

Prepared by Hilary A. Sandler

Always read the label of the pesticide when you have specific questions concerning storage or disposal. Pesticides should be stored in properly designed storage facilities that are well ventilated and maintain a cool, dry environment. Affix fire extinguishers on the outside and the inside of the building. Be sure to inform your local Fire Department which buildings on your property are storage facilities.

Avoid carry-over of pesticides; buy only what you will need for the current season. It is not advisable to use pesticides that have been held over in opened containers. Take the precautions necessary to prevent cross-contamination of all pesticides and fertilizers when stored in the same facility. If you have many different kinds of materials in your storage facility, it is helpful to place all insecticides in one area, all herbicides in another, etc. All materials should be clearly labeled. Post a list of materials outside of the building if possible.

Dry pesticides (e.g., granulars, powders) should be stored in a cool, dry place. Generally, no other special precautions are needed with these materials. Liquid or emulsified products may have restricted temperature ranges at which they should be stored. **CHECK THE LABEL!** In general, liquid or emulsified materials should not be stored at temperatures below 45°F or at temperatures that frequently exceed 100°F. These pesticides may form crystals at the lower temperatures. If crystals form, bring the pesticide into a warm place and gently agitate the pesticide container to re-dissolve the pesticide. **NOTE:** If you are storing Roundup, do not use galvanized or unlined steel (except stainless steel) containers. A highly combustible gas mixture may form.

Properly dispose of used containers. Check with your local supplier for any available recycling programs. A paper bag is considered by DEP to be empty if "all wastes have been removed that can be removed by shaking or equivalent means...". No more than one inch of material should remain. In addition, consider placing the pesticide bag in a plastic trash bag prior to disposal. For liquid-type materials, triple-rinse the container. Plastic containers should be recycled or reconditioned. For further information, contact the Pesticide Bureau at (617) 626-1776.

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